WATER WORKS AND SEWERAGE

ABC ABP

January, 1933 Vol. LXXX. No. 1

Editor

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Water Treatment has saved the Railroads *millions*

. . . . says Mr. Aishton

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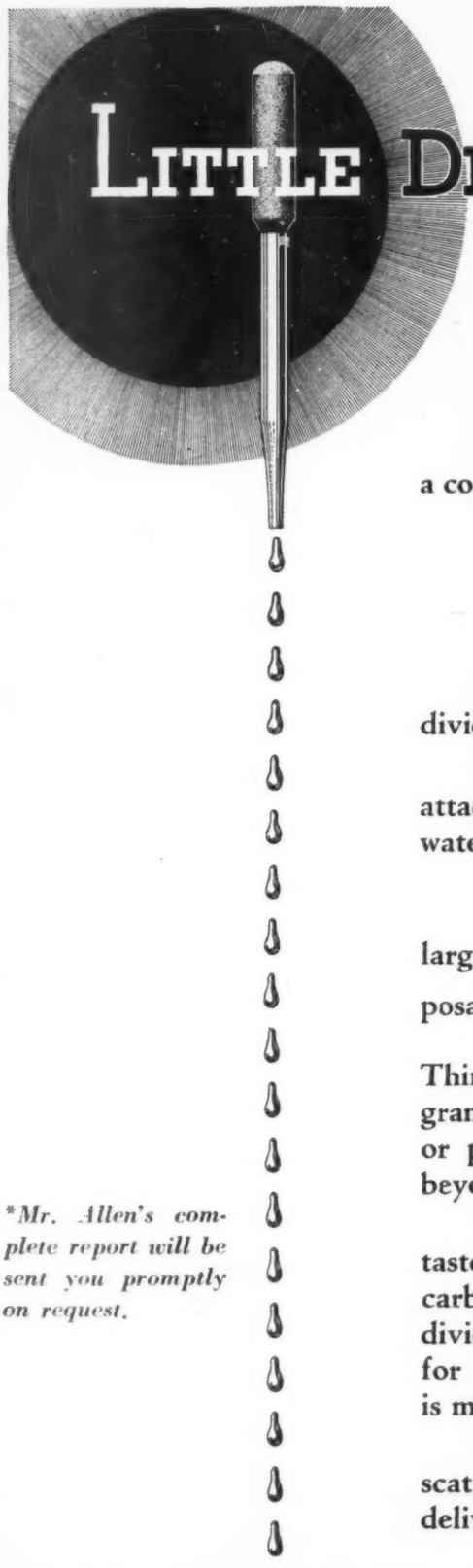

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WATER WORKS & SEWERAGE

L. H. ENSLOW, Editor

LEADING ARTICLES To Appear in the Next and Subsequent Issues:

George W. Fuller, Consulting Engineer of New York City, will review the "Developments of 1932 and Future Trends in the Sewerage Field" for the February issue.

A. F. Porzelius, Superintendent, City Water Company of Chattanooga, Tenn., will give some valuable suggestions and hints on the important topic of "Selling the Water Works to the Public." Good-will is frequently almost as essential as good water, and the author tells how it may be gotten.

Robert B. Morse, Chief Engineer of the Washington Suburban Sanitary Districts, Hyattsville, Md., will relate developments wherein the use of light weight cast iron pipe in large diameter sewer construction and small sizes lateral house connections in the Washington Suburban District has led to economy, simplified construction, permanency of structure and increased carrying capacities.

A. S. Behrman, Chemical Director of the International Filter Company, will relate experiences with the utilization of "Activated Carbon in Industrial Water Purification" in which some of the more important results secured are disclosed. The author also lists further possibilities from the utilization of activated carbon in the industrial water supply field.

C. E. Keefer, Engineer in Charge of Sewage Disposal at Baltimore, Md., in reporting the outcome of "Large Scale Sludge Digestion Experiments at Baltimore," will discuss and summarize hitherto unpublished information, covering the relative merits of digester heating by direct addition of hot water to the sludge vs. the orthodox use of hot water coils fastened to the interior tank walls.

George D. Norcom, Sanitary Engineer of the Federal Water Service Corporation, New York City, will discuss the use of "Bleaching Clay in Water Purification" — citing results secured through the use of absorbent clays for removal of tastes from industrially polluted municipal water supply. Oily tastes were the chief offenders effectively removed at a relatively low cost for the treatment.

Donald H. Maxwell, Consulting Engineer of the firm of Alvord, Burdick & Howson, Chicago, will recount actual experiences at Glencoe, Ill., in which the "Economy of Elevated Water Storage Is Strikingly Shown."

Eugene T. Cranch, Superintendent of the New Rochelle (N. Y.) Water Company, will continue with the series of articles of particular interest to Water Works Superintendents and Managers. The next will relate practical suggestions covering "Maintenance and Repairs to Fire Hydrants."

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AN ANSWER TO THE QUESTION:
"WHAT IS THE MEANING OF pH?"

pH *And Its* Practical Application

By *Frank L. LaMotte*
William R. Kenny
Allen B. Reed

TODAY the term "pH" is part of the routine vocabulary of almost every technical man, and the usefulness of the subject has benefited so many processes that it is now an accepted operating factor. So rapid has been its adoption throughout the technical world, that a great many routine workers now using some means of pH control do not have a clear understanding of the term "pH" itself, nor of the simple underlying principles involved in its measurement.

It is the purpose of this book to supply the need for such fundamental information in simple language, avoiding technical terms as much as possible.

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The broad scope of the book is indicated by the Table of Contents.

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WATER WORKS AND SEWERAGE

JAN. 1933

VOL. 80 — 1 No.

A GILLETTE PUBLICATION

WATER SUPPLY AND PURIFICATION DURING 1932

By NORMAN J. HOWARD

Director of Water Purification, Toronto, Ont.

IF one was asked for an opinion as to the extent and nature of developments in water supply and purification in the United States during the past year, it would have to be candidly admitted that not for a decade had there been such a pronounced cessation of necessary work and improvements. No advantage appears to have been taken of the prevailing unemployment and low construction costs. This is in striking contrast to conditions in Canada, where many major projects were started or completed during the year. At no time, in fact, since the termination of the Great War, have so many purification plants and water works extensions been made.

Due to lack of developments in the United States, which for several years prior to 1930 had led the world in expansion and improved treatment methods, there is comparatively little new upon which to enlarge. The trend to beautify old and new structures still remains an outstanding feature in engineering and architectural design. The prevailing financial conditions have, without doubt, increased the attention given during the year towards flexibility of equipment and treatment devices.

Contributions made in connection with rapid sand filtration were chiefly confined to improved methods of sand analysis, coarser filter sand, decreased thickness of sand and gravel, increased rate of backwash, improved filter bottoms and more effective and economical methods of flocculation. The part played by bleaching clay and powdered carbon in connection with coagulation, as demonstrated at some purification works was of considerable importance. A deal of work was carried out in an effort to combat corrosion by the use of cement or bitumastically lined pipes, and by the application of newly developed rust proof pigments. Powdered activated carbon was again the featured material used in securing taste and odor removal. At the end of 1932, some 396 installations were in operation. The use of chlorine in either large or small doses, in conjunction with powdered carbon, applied to the raw water prior to filtration, appears to have been successfully used at several plants. After a long delay, the Seventh Edition of Standard Methods of Water Analysis, was finally approved by the committee of the American Public Health Association at the Washington meeting. It is generally recognized that the major part of the research work carried out in connection with the preparation of the Seventh Edition of Standard Methods was performed by members of the American Waterworks Association.

Construction of Dams and Plants

Great progress was reported in construction of the Hoover Dam. The first stage of this work was completed in November last, when the diversion of the Colorado River from its normal channel by means of the by-pass tunnels in the canyon walls, was effected. Likewise, construction work on a large scale was carried out in connection with the three dams at present being built to supply water for Los Angeles, Pasadena and San Diego, Calif. These, together with the dam under construction for the Los Angeles Flood Control District, will give a total storage capacity of 208,000 acre ft. and involve a cost of 18 million dollars. Litigation in connection with the Colorado River aqueduct scheme, held up this project until late in the summer when the supreme court validated the proposition. This scheme will

bring water a distance of 240 miles to supply the thirteen cities comprising the Metropolitan Water District of Southern California. Due to seepage, it became necessary to regrout the Pardee Dam on the Mokelumne River in California. The seepage through this dam, which is 358 ft. high, was reduced by grouting from 2.8 sec. ft. to 0.85 sec. ft. The supplementary 20-mile tunnel, involved in the $42,692,867 contract bringing water from the Catskill aqueduct system to New York City, was holed through in the spring. The new tunnel is constructed through rock at depths varying between 200 and 700 feet. Considerable extensions were undertaken in connection with the Minneapolis water system, the City Commission recommending the continuation of the Mississippi River source of supply. The new works when completed will cost $10,000,000 and include a softening plant, a 20-million gallon reservoir and an activated carbon taste removal plant. At Elizabethtown, N. Y., a new filtration plant was completed having a capacity of 10.5 million gallons. The new features of this plant included double diversion weirs, intakes with reversible flow possible, large unbaffled subsidence basin, flexible arrangement of coagulating basins and non-pressure half round filter under-drains. An iron removal plant which was also designed to remove taste and odor, was built at Peru, Ind. This plant has a capacity of 3 million gallons daily, and includes mechanical aeration and square settling basins, one of which is equipped with a mechanical scraper. Another unusual plant was commenced at Elgin, Ill., also for the removal of iron and odors. The water in this case will be pumped into a pressure filter tank, the top portion of which is filled with compressed air. As the water passes through the top compartment, the iron in solution will be oxidized to the ferric state. The water then passes through a middle section of the tank which provides a definite retention period, during which time coagulation takes place. The water is thereafter filtered. A small softening plant was completed at Neodesha, Kan., having a capacity of 2 million gallons and costing $65,000. By changing over the steam pumping system to electrically operated pumps, a saving of $85,000 yearly is expected to result at Denver.

Canadian Undertakings

In Canada, chief work was in connection with the Toronto duplicate waterworks system. The 55 million gallon pure water reservoir was placed in commission during the year. The filtered water tunnel constructed at a cost in excess of $3,500,000, was completed and filled with water. The new intake tunnel some 3,300 feet in length extending out under Lake Ontario, and having a capacity of 300 million gallons daily was finished as far as the submerged shaft. An 8-ft. intake pipe extending a further 4,250 feet in the lake was half finished. Construction of a filtration plant having an initial capacity of 100,000,000 imperial gallons daily was commenced. The Toronto extensions will take two years to complete, and involve a total expenditure exceeding $14,000,000. In western Canada, the largest undertaking of recent years was practically completed for the city of Calgary at a cost of $4,000,000. This scheme included a concrete dam constructed across the Elbow River impounding 950 acres and providing a storage capacity of 3,600,000,000 gallons. The dam is 60 ft. high and 1,100 ft. long. A modern rapid sand filtration plant having a capacity of 28,000,000 gallons daily, together with 8½ miles of 36-in. lock-joint steel lined concrete pipe and extensions to the distributing system are part of the Calgary scheme. At Ottawa, a 35,000,000 gallon filtration plant was placed in commission, the construction costs being $1,526,000. Details of this plant were described in these columns some months ago. Another large plant of 40,000,000 gallons capacity was completed at Hamilton at a cost of approximately $1,100,000. The equipment includes two Dorr flocculators, these being the first of this modern type of coagulating device to be installed in a water purification plant in Canada. The filter backwash system is designed to provide a maximum rise of 42 vertical inches per minute. Additional plants were built at Oshawa (6 million gallons); at St. Thomas (4 million gallons), and at Lachine (6.66 million gallons). The last named plant has to be provided with a separate air-wash system. Smaller plants were built at Shawinigan Falls and Dorval, Que., and at Tilbury and Huntsville, Ont. Several well installations were placed in commission notably at London and Weston, Ont. Several large reservoirs were completed—the 30,000,000 gallon one at Quebec City having cost $1,000,000. Other reservoirs built were in the cities of Montreal and Oakville. Authorization was given by the Montreal Water Board for starting work on the suburban filtration and distribution extensions estimated to cost $750,000. Additional pumping equipment was installed at the Point St. Charles Pumping Station in Montreal at a cost of $500,000. Great progress was made on the water supply tunnel for greater Vancouver to connect the North and South shores across the Narrows. The length of this tunnel is 3,100 ft. and together with the control valves is expected to cost $1,250,000. The first municipal zeolite softening plant in Canada was installed at Etobicoke, Ont., at a cost of $53,000. The plant is of standard design and has a capacity of 1,500,000 gallons daily.

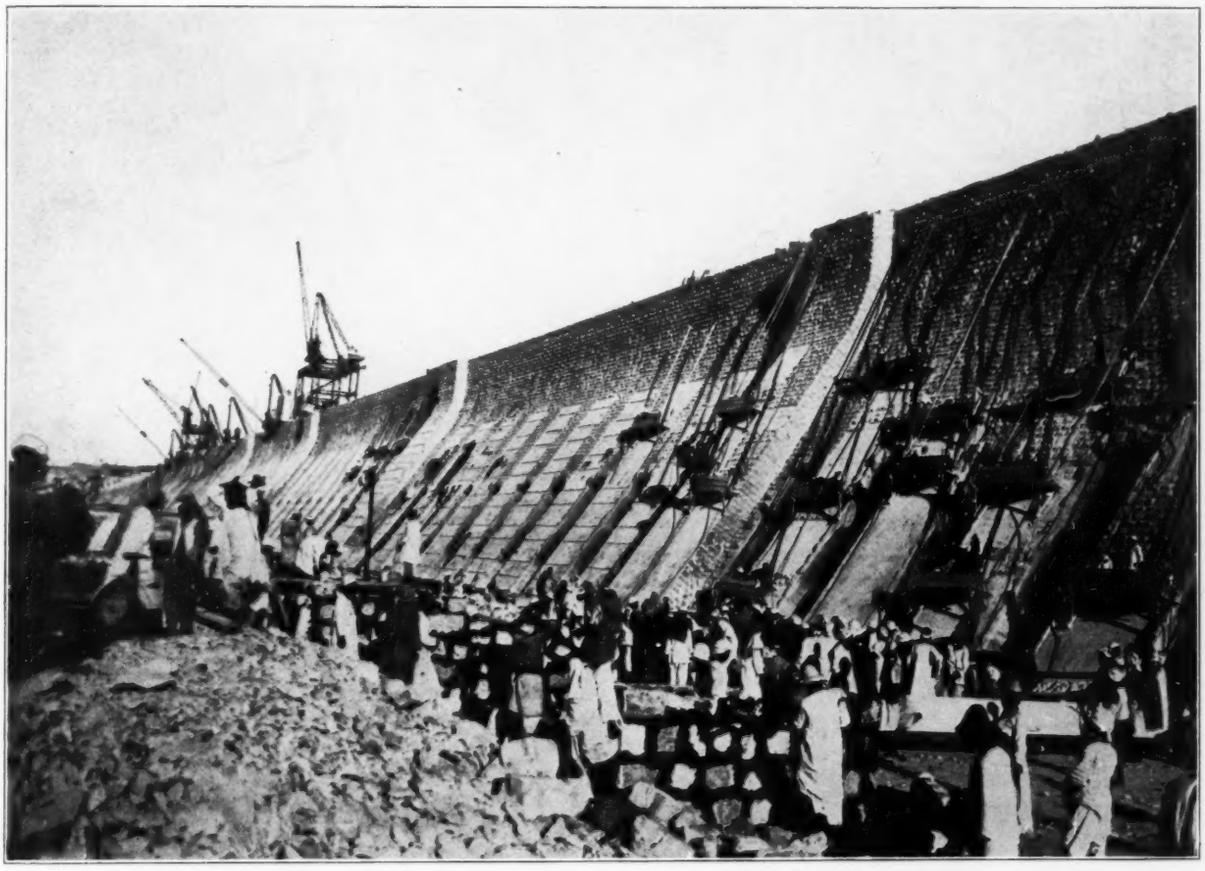
European Developments

In England the Metropolitan Water Board started construction on its 34 million gallons rapid sand system to be used ahead of the slow sand filtration. The new plant, to cost approximately $1,000,000, will allow the rate of filtration for the slow sand filters to be greatly increased. The board also completed the erection of a 60 million gallons electric pumping station, replacing the old steam system at Surbiton (R. Thames), at a cost of $1,000,000. Numerous other works of a smaller nature were carried out in England, notably the Milford Haven Dam and filtration plant and the Barnoldswick Reservoir which was completed at a cost of $750,000. A new water supply for Paris, France, was approved during the year. This project entails the building of infiltration galleries in the Loire Valley estimated to produce 250 million gallons daily at a total cost of $80,000,000. The water will flow by gravity to Paris for a distance of 90 miles through a 14 foot 9 inch aqueduct. During the year, the largest earthen dam having a catchment area of 77 square miles, was completed on the River Arvo at Nocelle in Italy. The raising of the Assuan Dam in Egypt was practically completed and will provide greatly increased head and storage capacity.

Developments with Filters, Sand, Washing and Flocculation

Regarding rapid sand filtration, the F. B. Leopold Co. of Pittsburgh, Pa., announced details of a new filter bottom containing no metal parts. The underdrain layout consists of a primary system comprising a concrete header flume and concrete laterals, in the top of which are glazed porcelain nozzles. On the top of the primary system precast concrete blocks are placed. These have corrugated tops and are perforated with small holes in

the tops of the corrugations. Only six inches of graded gravel are said to be necessary with this new system. In dealing with sand analysis, C. H. Wichers and E. Jacobs of Groninger, Holland, through the mediumship of the Journal of the American Waterworks Association, proposed a new granulometric test based upon the surface area of the grains per unit volume of compact sand and the volume of the voids or interstices per grain of compact sand. Their observations, and those of Messrs. R. Hulbert and D. Feber of Detroit, have thrown doubt as to the accuracy of the old uniformity co-efficient specification which in the past has been so extensively used. The Detroit workers, completed a study of the wash rate of 20 inches was found to give satisfactory results. During the year the Dorr Company announced a new mechanical device for coagulating water, known as the "Flocculator," of which Marsden C. Smith, Engineer of Water Supply at Richmond, Va., was the inventor. This consists of a number of large-radius paddles rotating about a horizontal axis. The direction of rotation is such that the paddles draw back into the mixing zone some of the flocculated matter deposited on the bottom of the sedimentation tank, thus aiding coagulation and decreasing the required amount of applied chemical. Considerable economy and improved flocculation was reported at Richmond. There have been three



Assuan Dam on the Nile. Egypt's Mightiest Structure

hydraulic loss of head occurring during the passage of filtered water through graded sand, which enabled them to develop a new loss of head formula. It is thought that their formula will give a better picturization of the hydraulics of filter sand and serve to illustrate more clearly what actually happens within the sand bed itself than has heretofore been the case. A new machine, developed in Newark for sand analysis, consists of a testing sieve shaker equipped with a ¼ h.p. motor and an automatic time switch. A. B. Morrill reported that the new filtration plant at Detroit would only employ 20 inches of sand in the filters. This amount was found to be sufficient in the experimental filters upon which the design of the new plant was based. The Detroit authorities consider the presence of sand having an effective size less than 0.3 m.m. to be undesirable in filter beds. At Chicago, J. R. Baylis has found that mud balls and surface cracks formed as result of poor backwashing, chiefly at a rate of 24 inches. Even a vertical rise of 38 inches per minute was not always satisfactory. Using a surface jet-wash to a depth of 4 inches, together with a back-

other installations since. A new chemical feeder for applying ferric chloride was developed in Chicago, all of the mechanical parts which come in contact with the chemical being made of rubber. A new solution feeder of all glass and rubber construction has been developed by the Phipps-Bird Co. of Richmond, Va. The use of lime and chlorine was reported by E. K. Ventre of Monroe, La., who found that operating costs over a limited period were reduced from $9.49 per million gallons when using alum-lime-prechlorination treatment to $3.38 for the lime-chlorine treatment. He suggested the use of lime-chlorine treatment utilizing the iron normally present in the raw water as a cheap and effective aid to coagulation. Some years ago L. H. Enslow was the first to suggest that the possible presence of iron in water accounted for improved flocculation, when prechlorination was practiced. At the Providence, R. I., filtration plant (30 m.g.d.) chlorinated ferrous sulphate (chlorinated copperas) has been successfully and economically used as the coagulant. Prechlorination serves to oxidize ferrous iron naturally present in the raw water.

Corrosion Prevention

As previously mentioned much progress was made in efforts to remedy the corrosive properties of water. In dealing with this subject, U. R. Evans, England, emphasized the necessity of the "intentional introduction into the metal of constituents to reduce attack and improved methods of surface covering." In Maryland, A. W. Blohm, by installing a vent condenser on the boiler feed water and removing dissolved oxygen, halted the corrosion of the piping system. An intensive study carried out in Germany by H. Winter and H. Moning on the composition of 30 mine waters showed no direct relationship between the pH and total mineral salts. The tendency to corrode steel was not directly proportionate to the pH value of the water. The use of bitumen lined steel water mains is extending rapidly in Europe, chiefly on account of its resistance to tuberculation, its lasting surface and freedom from subsequent taste problems. F. W. Hammond and A. Goffey, England, recently recommended the use of electrolytically deposited bitumen on pipes for protection against tuberculation caused by iron-bacteria in acid-reacting waters. Sir R. Hatfield, London, before the British Society of Civil Engineers, described a new British pigment specially processed and so treated that it could be applied as a paint. Iron and steel painted with this preparation becomes covered with a metallic film which cannot be removed by scraping or rubbing, and resists corrosive influences. Another preparation was announced in Cleveland, designated as "Rust-tox," consisting of a colorless and transparent fluid for the protection of metals against rusting. This can be applied on rough surfaces and is not affected by heat. The National Research Council of Canada, announced the perfection of cements which successfully resisted sulphate (alkali) action. At Iowa City, E. Bartow and O. M. Weigle suggested that if pure zinc was used in manufacture of galvanized piping, the soluble zinc salts in certain waters would be greatly reduced. The use of new ternary alloys, consisting of lead-cadmium-antimony and lead-cadmium-tin, possessing mechanical strength and resistance to fatigue far higher than lead pipes was announced by the British Non-Ferrous Metals Research Association. Builders' Iron Foundry at Providence developed a new electrically driven device, known as the Chrono-flow meter. This machine indicates and records the flow of liquids with either a venturi tube or orifice plate.

Water Softening Lags

Very few contributions were made on water softening. The two best papers of the year were by R. E. Thompson, Toronto, before the Canadian Public Health Association, and by Messrs. H. W. Hudson and A. M. Buswell before the Illinois Section of the A. W. W. A. In analyzing the loss involved through the use of excessively hard waters, a practical example was given of the supply at Chicago Heights using a water containing 555 parts of hardness. In this case, the estimated wastage of soap was computed at 10,060 pounds daily, equivalent to $81,900 yearly. In Germany, increasing technical opinion suggests the periodic use of tri-sodium phosphate for final treatment of boiler waters.

Chlorination Developments

The use of chlorine in water treatment was further extended during the year, chiefly in its application in the prechlorination of raw waters. W. L. Mallman drew attention to the fact that the germicidal action of chlorine, was affected by the pH of the water under treatment. Increased alkalinity necessitated longer periods for effective sterilization. Intermittent rather than continuous treatment of 287 million gallons daily, of steam condenser water at Powerton, Ill., was found to be effective in controlling slime deposition and to greatly decrease the chlorine consumption. The Paterson Engineering Co. of Canada installed an automatic chlorine shut-off valve at the International Nickel Works at Sudbury, Ont., the central station being four miles away. This device which is new to America consists of a solenoid or hydraulically operated valve which automatically restricts the flow of chlorine at a given time. The device, however, can only be used in conjunction with the Paterson chlorine valve in which there is neither packing nor packing glands.

Taste and Odor Control Measures

Further progress was made during the year in the elimination of tastes and odors from water supplies. The best contribution to this subject during the year was made by J. R. Baylis in the Journal of the A. W. W. A. He clearly outlined the limitations of the various methods at present in use. As Baylis said in his article "The public is reaching the stage when they will no longer tolerate disagreeable tastes in their drinking water." The use of pre-ammoniation did not extend greatly, but a majority of places where this form of treatment had proved to be effective have retained it as a routine practice. Permanganization was used to a small degree for taste prevention and for control of algae. Superchlorination with subsequent dechlorination continues to be used in three cities only, while the use of activated carbon has outdistanced all other forms of treatment. The use of bleaching clay was successfully reported at Chester, Pa., by R. I. Dodd, who found that this substance absorbed the highly hydrolized oily substances and phenols. The maximum, minimum and average dose used was 0.6, 0.1 and 0.30 grain per gallon at an average cost of $0.35 per million gallons.

As previously mentioned, the use of powdered activated carbon has greatly increased, far more so in the past two years than the most optimistic observer could ever have anticipated. With close upon 400 installations at present in use, its future possibility has no limitations. The outstanding points reported during the year include: (1) The unquestionable value in removing tastes and odors from water; (2) its successful use with other reagents or processes, notably with prechlorination; (3) its value in stabilizing sludge in coagulating basins chiefly in warm weather; (4) its joint use with alum resulting in freedom of taste, improved floc formation and reduced operating costs.

With increased use of powdered carbon, numerous brands have appeared on the market, some having limited value. J. R. Baylis endeavored to evaluate carbon by its ability to remove phenol from water. Unfortunately, this only furnished information on this particular type of taste forming substance, and the experience of the city of Saginaw, Mich., indicated the test to be of limited value. When examining some 13 grades of carbon by the Baylis test, some of the proven brands of carbon were given doubtful values. Important studies in taste absorption were made by Mortimer Gibbons at Rahway, N. J., on a plant scale. He found carbon to be distinctly selective in character, some odors were completely removed, while others notably that caused by the algae synura were only slightly reduced. Prechlorination in high dosages followed by activated carbon treatment, was completely successful. Gibbons found (1) potassium permanganate removed tastes and odors

caused by solvent naphtha wastes, rosin soap wastes and fermenting cereal wastes, (2) powdered activated carbon alone removed tastes and odors from several organic wastes, had a wider range of effectiveness than other processes but is expensive, (3) super-chlorination combined with activated carbon was most effective against phenol groups, (4) potassium permanganate combined with activated carbon was effective against lacquer-solvent wastes. W. P. Hughes of Weiser, Idaho, reported that super-chlorination followed by activated carbon treatment was effective in preventing taste and odor caused by algae after pre-ammoniation had failed. Where practical, the most reliable treatment would seem to be super-chlorination followed by a later application of powdered carbon. This treatment was originally suggested by J. R. Baylis, Chicago. Some of the newest features of activated carbon revealed during the year were recently brought out by F. E. Stuart, New York, in his paper before the Third Annual Short School for Filtration Plant Operators at the University of Tennessee. He stressed the stabilization of sludge which has been confirmed by several observers, and the fact that powdered carbon, to the amount required, in contact with a chlorine containing water will not absorb the chlorine unless carbon is applied in doses exceeding 16 pounds per million gallons. In dealing with improved flocculation, Stuart introduced a somewhat novel line of thought. He stated "This improvement in coagulation was first credited to artificial turbidity presented by the carbon. It appears that the turbidity created by the carbon is entirely different from ordinary silt and clay turbidity, as it is highly adsorptive in nature and bears the same electric-charge as the coagulant, whereas silt and clay are normally negatively charged. Further, it appears that this turbidity does not create floc formation as credited to artificial turbidity because carbon causes an improvement in clarification when used in a softening plant where turbidities far exceed that of an ordinary filter plant." An important point is, that better floc formation occurs when small doses rather than large doses of carbon are used. While all may not agree with the theory involved in Stuart's viewpoint, particularly when better results are obtained with smaller doses of carbon, the fact remains that his observations have been confirmed by J. E. Kerslake at Ossington, N. Y., S. D. Poach, Olean, N. Y., and some eight other cities. The most interesting application of the year was the use of powdered carbon without filtration in some of the southern states, notably Oklahoma, Louisiana and Texas. The carbon was applied for taste and odor prevention and added with the coagulant in sedimentation basins. The treatment was completely successful without any trouble in the distribution system. In England, B. A. Adams found that all forms of iodine were removed completely by treatment with activated carbon. This viewpoint was disputed by Doctors Beale and Suckling, who questioned the accuracy of present-day methods of estimating iodine in water. In discussing the prevalence of goitre and its relationship to water supplies deficient in iodine, the last named doctors stated that the part played by drinking water in supplying iodine could probably be neglected because in a goitrous area the deficiency of iodine in all the foodstuffs cannot be made good by that in the water, and in a non-goitrous area the amount of iodine in the water constitutes so small a proportion of the whole in all articles of diet, that its absence would not be felt.

The experimental use of ozone was reported upon by Sir Alexander Houston at London. In dealing with an experimental plant capable of treating 5,120 gallons per hour, an average dose of 1.48 parts per million was used. The bacterial count showed a reduction of 95.2 per cent, while B. Coli tests were 100 per cent negative. Color was reduced 55 per cent and taste conditions improved. Chloro-phenol tastes (artificially produced) were completely removed by the treatment.

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Accuracy Is Essential in Making Residual Chlorine Determinations

The test for residual chlorine in treated water is, with the exception of bacteriological analysis, the most important criterion of effective chlorination. In New York State, the usual method of making this determination is the so-called "orthotolidine test." Unless this examination is properly made and correctly interpreted, false results are obtained. This was forcefully illustrated recently in connection with the chlorination of an upstate city water supply.

The supply referred to is obtained from an impounding reservoir near the city and is chlorinated by means of equipment which automatically varies the chlorine dosage with the changes in the rate of flow of water through the pipe line. The records of operation of the chlorinator indicated that a residual of free chlorine was being maintained in the treated water. Samples collected from representative taps in various sections of the city, however, were found to have high bacterial counts and to contain *B. coli.*

In view of these findings, the local authorities, on recommendation of the State Department of Health, increased the amount of chlorine applied to the water. An investigation made by an engineer of the Division of Sanitation showed that the operator had been conscientious in making the tests for residual chlorine, but due to incorrect methods the determinations indicated a much higher residual than was actually present.

The sampling tap for use in making the orthotolidine test was from a take-off pipe a short distance below the point of application of the chlorine. The operator had collected a sample of water from this tap daily and immediately added the orthotolidine solution. The proper procedure is to wait ten minutes before adding the solution in order to allow for absorption of chlorine by organic matter. The sample should then be left standing five minutes before making the reading. On the day of the inspection, according to the operator's reading, a residual of 0.4 p.p.m. existed. A determination made by the engineer indicated that the true residual was but 0.1 p.p.m. Before the rate of application of chlorine was increased, the water was not being effectively chlorinated and it is probable that there was no appreciable residual present.

A sample of water collected after the dosage of chlorine had been properly adjusted was found to have low bacterial counts and to be free from *B. coli.*—From December, 1932, *Health News*, New York State Department of Health.

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SELF-LIQUIDATING SEWERAGE PROJECTS. — Eleven states now have laws which enable their cities to build sewers and disposal plants as self-liquidating projects, eligible for R. F. C. loans. Loans can be repaid from actual service charges paid by users of the system, without resort to general taxation.

THE IMPORTANCE OF TESTING DISC METERS AT THE CORRECT RATES OF FLOW

By P. S. WILSON
Consultant in Water Works Management, Glen Ridge, N. J.

P. S. WILSON

A TYPICAL registration curve of disc type water meters is shown in Fig. 1. In this curve the percentage of the water actually registered during passage through the meter is plotted against the rate of flow in gallons per minute. Individual meters would vary somewhat from this curve depending upon the design of the meter and its condition but they would all assume the same general form, provided they were in good repair and operating properly.

The curve as a whole may be shifted upwards or downwards by altering the gearing of the meters but this will not change the general shape of the curve. The curve shown in the figure is drawn for five-eighths inch meters but the corresponding curve for any size of disc meter will have much the same shape in relation to the total range of capacity of the meter.

The important fact to observe regarding this curve is the fact that it is a curve and not a straight line. In other words, even above the low flows which the meter will not register, the percentage registered is not the same at different rates of flow. There is an intermediate point of maximum registration and a reduction both ways from this point, more abrupt for the lower flow. All of the reasons for the shape of this curve are not entirely clear and there is some difference of opinion regarding them. Contributing factors are that at the low flows the leakage through the clearances of the meter is a larger proportion of the total flow, and at the same time there is less power available to overcome the friction between the moving parts of the mechanism. At high flows the meter is approaching its capacity, the loss of head through the meter is greater and this results in greater pressure differences to cause leakage through the clearances.

Meter manufacturers endeavor to produce meters the test results of which will plot as nearly a straight line as possible, that is, registering as nearly as possible the same percentage at all different rates of flow. This goal is practically never reached, for some clearance must exist in the meter in order to reduce friction. The curve will be flatter if the parts are more accurately manufactured and fitted. In the cases of meters of poor design or which are poorly fitted or in poor repair the curve may be very much more pronounced than shown in Fig. 1, or it may show irregularities.

Importance of Testing at Several Rates of Flow

The purpose of testing a meter is to determine the percentage of the water passing the meter which is registered by it. As explained above, this percentage is normally different at different rates of flow. In routine meter shop practice it is of course impractical to test a meter at every rate of flow under which it will actually operate, and yet we must have assurance that it will register within the limits of accuracy adopted at all of these different rates. We know that a test at a single point on the curve, that is, at a single rate of flow, will not give us the percentage registered at other rates of flow. The curve may be of different curvature depending upon the condition of the meter, and we are making the test because we do not know the condition of the meter. If the clearances in the disc chamber are too great, for example, the meter will not register the low flows well and its curve will drop off too rapidly at that end. If the "control" is not close enough, that is, if the spindle is not held at the proper angle, the meter's registration curve will in all probability go up too high at the intermediate rates of flow. With the multiplicity of parts in a meter there are of course many other defects which may have various effects upon the performance of the mechanism as a whole.

The endeavor must be to test the meter at the least number of rates which will serve to indicate with sufficient reliability what the performance will be over the rest of its range of capacity. It has been found that in normal practice it is necessary to make a test at each one of three different rates of flow, unless the condition of the meter is already quite well known. In order to obtain reliable information from as few as three different rates of test these rates must be carefully chosen in order to show up the true form of the curve and to know that there are no irregularities in it between the points located by the tests. We are in much the same position as is the surveyor who must determine the cross

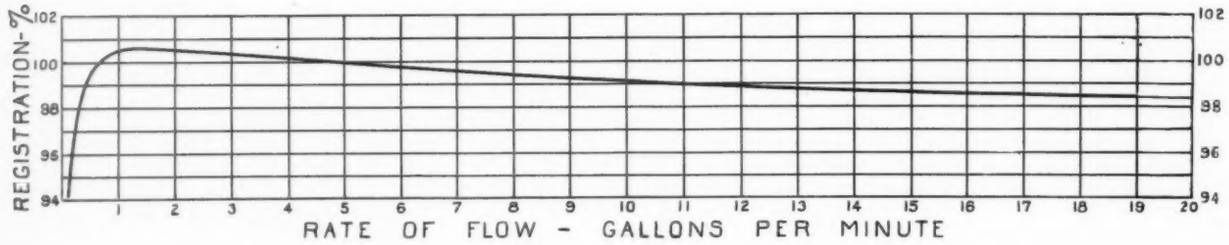

Fig. 1—Curve Showing Accuracy of Meter Registration at Variable Rates of Draught

section of a river bottom for a pipe line crossing and only has time to make three soundings of the depth. He must choose the location of each sounding with care in order to gain the maximum amount of information, since the depth at points between soundings may be only assumed.

The three rates of flow at which a disc meter should be tested are usually termed the "Low" or "Minimum" test flow, the "Intermediate" or "Medium" test flow, and the "High" or "Full" flow. They are of course chosen having in mind the probable form of the curve of registration of the meter. They are different for different sizes of meters in order to maintain approximately the same relative positions with relation to the total range of capacity of the meter.

Minimum Flow Test Requirements

The "Low" or "Minimum" flow test is made in order to determine that the meter does not drop off in registration at any higher rate of flow than economically possible, in other words, the meter must be able to register down to a certain predetermined low rate with sufficient accuracy. Since the accuracy of registration at low flows depends to a large extent upon the reduction of clearances and at the same time the avoidance of friction in the meter, and since these in turn call for accurately fitted parts, the choice of the low rate of test flow and the percentage of registration to be gained at that flow depend, within limits, upon the economic considerations involving the cost of manufacturing and repairing meters and the gains in revenue to be made. The low test flow must of course be greater with large disk meters than will small ones, because the total cross sectional area of the clearances in a large disc chamber must of necessity be greater than in a small one. This variation of the test flow with different sizes of meters makes it possible to apply the same specification covering percentage of registration to all sizes. The rates of flow called for as "Minimum Test Flow" in the Standard Specifications for Disc Type Meters as adopted by the American Water Works Association and the New England Water Works Association, and reproduced herewith as Table I, are the rates of flow in common use. Different organizations vary somewhat the required percentage of registration at these flows to suit individual views and conditions. The Standard Specifications referred to call for at least 90 per cent registration at minimum test flows. Good manufacturing methods and skillful repair work can be considerably better than this on both new and repaired meters, 94 per cent or 96 per cent being not unreasonable to expect.

TABLE I.

Rates of Test Flow. From Standard Specifications for Cold Water Meters, Disc Type, Adopted by the A. W. W. A. June 19, 1921, and by the N. E. W. W. A. Sept. 14, 1921.

Size of Meter (Inches)	Normal Test Flow Limits (Gallons per Minute)	Minimum Test Flow (Gallons per Minute)
⅝	1 to 20	¼
¾	2 to 34	½
1	3 to 53	¾
1½	5 to 100	1½
2	8 to 160	2
3	16 to 315	4
4	28 to 500	7
6	48 to 1000	12

Intermediate Flow Test Requirements

The Intermediate test flow should be chosen so as to ascertain that the registration at the high point of the curve does not go too high. The rate should, therefore, be such as to aim for the probable highest point. This will vary with different makes and types of meters but it will usually be found at, or a little higher than, the lower figure given under "Normal Test Flow Limits" in the Standard Specifications—see Table I. For a five-eighths inch meter the table gives 1 gal. per min. and the test flow should usually be from 1 to 2 gal. per min., depending upon the characteristics of the particular make and type of meter under test. These may be ascertained by careful trial of a number of meters in each case.

If the meter is geared and fitted so as to maintain a good registration at the low and high flows then the difficulty in most cases will be to keep the registration down at the intermediate flow. The standard specifications allow a meter to go up to 102 per cent registration and it is considered good practice by many to put meters into service showing slightly over 100 per cent at the intermediate flow on the assumption that such over-registration will average up fairly with the under-registrations which are unavoidable at other rates. This is probably well justified in theory but it is sometimes difficult to convince a customer of it. The flatter that the curve for the meter is, the less need there is for such practice. This is one of the many things to be considered in selecting a meter.

High Flow Test Requirements

The high flow test is considered by some to be the least important. This is unfortunate because it is the quickest and most convenient to perform. The exact rate of flow to be used at this test certainly is less important than with the low and intermediate tests because at rates of flow above the intermediate the curve is not apt to rise or fall so markedly. Many shops use a high test flow equal to the higher figure given under "Normal Test Flow Limits" in the standard specifications (Table I). For a five-eighths inch meter the 20 gal. per min. flow is approximately the maximum rated capacity of the meter. The practical objection to using this figure for the high test flow is that in very few cases will the service pipe and plumbing in a residence pass nearly so high a rate of flow and we are therefore testing at a rate beyond that at which the meter will ever operate at. Between 50 per cent and 75 per cent of this high figure is a more logical one to use for testing in routine procedure. We are quite safe in assuming that the meter registration will not be much different at higher rates in the few cases where such will occur. The rate of flow, at which it is decided to test, should be strictly adhered to in any case in order to obtain accurately comparable results. At the high flow the percentage registered should again be kept up, as in the low flow, and a minimum of 98 per cent is often specified in accordance with the standard specifications.

With water of a quality that causes meters to "speed up" after being some time in service, a lower percentage figure, depending upon experience, should be used for both high and low and the intermediate tests in order to prevent over-registration of the meter after it has been installed for a while. Such over-registration is not apt to be great but it is sometimes magnified in importance from the viewpoint of the customer and leads to decidedly unfriendly relations.

Having given consideration to the reasons for choosing each one of the three different rates of test flow it is of course self evident that it is of equal importance to

TABLE II.

Discharge of Orifices in gallons per Minute. The smaller of the two figures given in each case is the discharge of a sharp edged orifice in a thin plate. The larger figure is the discharge with properly rounded edges.

Size of Orifice— Inches	Pressure—Pounds Per Square Inch 40	60	80	100
1/32....	0.11— 0.18	0.13— 0.22	0.16— 0.26	0.18— 0.29
1/16....	0.44— 0.74	0.54— 0.90	0.62— 1.0	0.70— 1.2
1/8	1.8 — 3.0	2.2 — 3.6	2.5 — 4.2	2.8 — 4.7
3/16....	4.0 — 6.7	4.9 — 8.2	5.6 — 9.4	6.3 —10.5
1/4	7.1 —11.8	8.7 —14.5	10.0 —16.7	11.2 —18.7
5/16....	11.1 —18.5	13.6 —23.	15.7 —26.	17.5 —29.
3/8	16.0 —27.	19.6 —33.	23. —38.	25. —42.
7/16....	22. —36.	27. —44.	31. —51.	34. —57.
1/2	28. —47.	35. —58.	40. —67.	45. —75.

actually perform the tests at those rates, in other words, to measure with reasonable accuracy just what the rate of flow is during the test and to adjust it to the correct figure. We are still in the position of the surveyor with his river soundings. The results of the most careful soundings are uncertain and the surveyor's conclusions are likely to be inaccurate if he fails to make measurements accurately which should give him the distance of his soundings from the shore.

Importance of Accurately Measuring Flows

The most frequently used means of determining the rate of test flow is with an orifice. No fault can be found with this means if we really know how much water is flowing through the orifice. The greatest trouble with this method for measuring the rate is that the diameter of the orifice is not the only thing which determines the number of gallons per minute which may flow through it. When, as is so often done, the flow is stated to be "a one-sixteenth inch stream," for instance, the actual rate may be anything within a comparatively wide range and may fall at an entirely different point on the meter registration curve from that assumed. The rate of flow through an orifice of a given size depends principally upon the shape of the edges of the hole, the thickness of the plate in which the hole is drilled, and upon the effective pressure acting to push the water through the hole. Rather than to state the size of the orifice it is far more definite to give the rate of flow in gallons per minute, or as the number of seconds to pass one cubic foot, as is done in up to the minute shops.

Table II gives the uncertainties of using orifices which have not been actually tested under fixed and known pressures. For example, a one-sixteenth inch orifice under a pressure of eighty pounds per square inch may discharge as much as one gallon per minute if the inner corners of the hole are properly rounded. On the other hand if the edges of the hole are sharp and square and the plate through which the hole is drilled is thin the discharge may be less than two-thirds of a gallon per minute under the same pressure. Variations in the effective pressure added to the above uncertainties will of course cause even greater indefiniteness in the discharge. At forty pounds per square inch the discharge of the one-sixteenth inch sharp edged orifice may be considerably less than one-half gallon per minute, while an increase of the pressure to one hundred pounds per square inch will produce a discharge through the same orifice with rounded edges of over two and one-half times as much. Such uncertainties as these will greatly nullify the benefits of otherwise careful testing.

The best way to determine that the correct rate of flow is being used is to actually use a watch, and preferably a stop watch, to time the flow of a certain quantity of water. If meters are being tested at a flow of one-quarter gallon per minute then it should take four minutes to pass one gallon and it should take forty minutes for the ten gallon test. At one gallon per minute the ten gallon test should take ten minutes. By such means an orifice or a valve setting may be chosen by trial to give each flow correctly and thereafter, as long as the pressure and other conditions remain constant, the time need only be occasionally checked. The test flows should be stated in terms of definite figures, such as gallons per minute, and not in terms of the size of the orifice or the number of turns of the valve wheel.

The figures given in Table II are the theoretical figures as to the discharge in gallons per minute of different sizes of orifices under different pressures. The smaller

A Well Equipped Meter Testing Shop. Note the Valve and Gage Arrangements, Also the Measuring Tank

of the two figures given in each case is the discharge with a sharp edged orifice in a thin plate, or with the edges properly bevelled on the outlet side. The larger figure is the maximum discharge to be expected with properly rounded edges on the inlet side of the orifice plate. These figures may serve as a guide in the choice by trial sizes of orifices to be used for obtaining certain rates of discharge. Actual measurement and timing should be employed to check each one, however. It must be remembered that the pressure which is effective upon the orifice will only be shown correctly by a gage located next to the orifice, and beyond the meter being tested, and that the pressure reading must be taken while the flow has become steady and constant.

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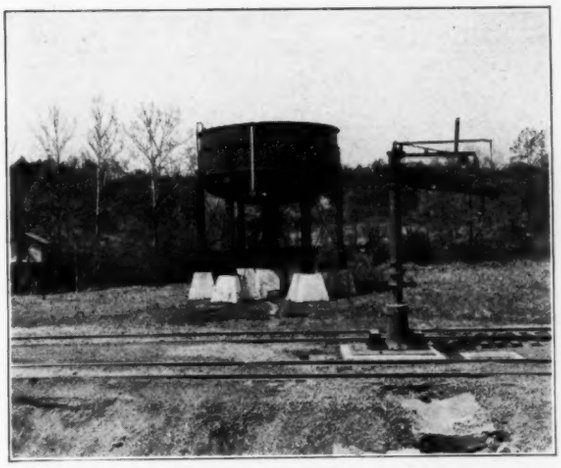
Long Distance Water Supplies—The following table for a booklet issued recently by the Burns & McDonnell Engineering Co., Kansas City, Mo., lists some of the cities of this country that go a long distance to secure their water supply:

	Miles
Los Angeles—Colorado River (12 cities supplied from this system)	339
Los Angeles—Owens River	250
San Francisco—Hetch-Hetchy project	175
New York City—Schoharie Reservoir	110
Denver, Colo.	110
Seattle, Wash.	105
Portland, Ore.	65
Tulsa, Okla.	58
Tacoma, Wash.	57
Phoenix, Ariz.	42
Lexington, Mass.	40
Greeley, Colo.	32
Everett, Wash.	29
Boulder, Colo.	28

WATER TREATMENT FOR RAILWAY SYSTEMS

By R. C. BARDWELL

Superintendent of Water Supply,
Chesapeake & Ohio Railway System,
Richmond, Va.



Norfolk & Western Ry., Payne, Va., Sodium Aluminate Wayside Treatment Plant. (Small Building at Left Is All That Is Required for Such Treatment.)

IN THE early stages of the development and application of steam power for transportation in the United States, recently celebrating the completion of its first century of progress, the major problems were confined to the practicability of something which would run and give service and facilities on which such equipment could be used. Although water supply was necessary for the operation of such units, the demands were so moderate as to be largely overshadowed by other requirements. It also appears that this early development took place largely in the eastern sections of the country where the water quality for boiler power use is not so severe and the realization of the importance of such requirements was slow to develop.

With the extension of railway lines into the Middle West where it was frequently possible to secure only water supplies containing considerable dissolved minerals, the effect of inferior water quality began to draw attention. With the increase in size and service demanded from these mobile power units, the influence of the water quality assumed even greater importance. In some of the more highly mineralized sections of the country the water quality actually became an influencing factor in the capacity of some railroads to handle the business.

In 1870, long before there was a water treating plant in this country, the American Railway Master Mechanics Association began a careful study of the greater cost of operating locomotives in a hard water district as compared with a soft water district. The results of this investigation, which were published in 1873, indicated that the comparison of costs between the average boiler of the soft water districts of the New England States and the average boiler using the harder water in the Middle West showed an annual difference of $340 per locomotive in the coal bill (coal then being $2.50 per ton), of $360 in boiler repairs, and of $50 in boiler cleaning, making up a total difference of $750 per locomotive per year. The present day locomotive evaporates many times as much water as the small locomotives of 1870 and in addition labor and material costs are much higher. Comparitive estimates have been made indicating that similar figures applied under present conditions, without corrections applied to many supplies, would show an annual difference of between $3,000 and $4,500 per locomotive per year, thereby representing considerable expense in the aggregate.

Although the 1873 report revealed the large losses which were being caused by using unsuitable water, called attention to the development in water softening in foreign countries and strongly recommended that the methods which had been demonstrated in the University laboratories be developed on a large scale, the state of the art of water softening in this country was so undeveloped at the time that nothing of practical importance was done for more than twenty years. It is highly probable that the long delay in taking advantage of such economies may also have been due to a lack of centralized planning, with the pronounced lack of definite responsibility in the handling of railroad water supply. Such handling of railroad water requirements has been varied and changeable due to the fact that the facilities are usually designed and installed by the Construction Department, operated and maintained by the Maintenance Department, used in the equipment of the Mechanical Department whereas the results directly affected the Operating Department. Under such conditions full coordination and cooperation is necessarily required to accomplish progress. Further, the flowery and extravagant claims of unscrupulous purveyors of "cure-all" boiler treatments which promised to accomplish exactly what was desired without the need for capital expenditures necessary in providing facilities affording permanent relief, were occasionally grasped with high hopes which would eventually fail in substantiation. Hope springing eternal, every new and improved product offered would be given a trial. Real advancement was confined largely, however, to the comparatively few cases where planning and supervision was conducted under scientific laboratory control.

WATER WORKS & SEWERAGE for December, 1932, contained the first of two articles dealing with "Railway Water Supply Practices," by Mr. Bardwell.

In this second article the author, who is an authority on matters pertaining to railway water supply practice, tells of appurtenances used, economies effected and recent developments in the treatment of water for railway use.

In a subsequent issue, methods of treatment control will be discussed. Other authors will also contribute articles on railway water supply practices, including the use of Zeolite methods of water softening and other modern developments in this field. —Editor.

Early Railway Water Treatment Plants

According to available records, the first plant for softening water on an American railroad was installed in December, 1891, on the Oregon Short Line Division of the Union Pacific Railway, and the second in 1896 on the Southern Pacific Railway at Port Los Angeles. Both of these plants were of the "intermittent" type which was characteristic of the early railroad water softening in-

stallations, many of which are still in service and giving good results, using the original Porter-Clarke process of adding soda ash to eliminate the non-carbonate hardness and hydrated or unslacked lime to remove the bicarbonates. This simple and practical arrangement consists of two or more tanks into which the water is alternately pumped, chemicals added and agitated, the water settled and then delivered for boiler use. Many such installations are still in use where an additional roadside tank has been erected, a small jet with chemical line run to top of tank, perforated air lines in bottom of tank supplied by a second-hand locomotive air pump located in the steam pumping plant house, and the delivery

Chesapeake & Ohio Ry., Huntington, W. Va. One of the Largest Intermittent Type of Softening Plants

outlet located a few feet above the tank bottom to provide for sludge accumulation which is removed periodically. The efficiency of such plants has not been improved appreciably in even the most modern installations largely because of the considerable advantage gained by the stirring up of the old sludge with each batch treatment which promotes the chemical reactions and serves as a nucleus for the formation of the new precipitate in larger particles which settle more readily. There was no complicated machinery and all parts were readily accessible and their operation easily understood. The disadvantages lay in the requirement of too much room where space was at a premium, and the lack of flexibility where the number of tanks were limited.

The first "continuous" lime-soda water softening plant on an American railroad was installed by the late C. Hershel Koyl on the Rio Grande Western Railway at Helper, Utah, in 1900. By "continuous" is meant the addition of the softening chemicals to the water as it is pumped, a reaction chamber being provided followed by a sedimentation chamber, the softened and clarified water leaving the latter being delivered to the storage tank or direct to service lines. Such equipment naturally attracted inventive possibilities resulting in patents, organized distribution companies and advertising and publicity. The net result was a direct benefit to the railroads inasmuch as these developments called attention to the economies available, and seemed to have been responsible for the considerable increase in interest in improved water supply and the number of railroad water softening installations which went into service during the decade, 1900 to 1910. The two principal water softening companies during this period appear to have been the Kennicott Co., of Chicago and the American Water Softening Co., of Philadelphia. They not only performed constructive work in the development of equipment but also served as a clearing house for the collection of information and exchange of experience.

Further Developments in Continuous Treatment

The "continuous" type of softening plant has been further developed since this period and appears to meet with favor in present plant construction for the lime-soda process of water softening. The essentials which are incorporated in the design of present plants are, (1) a steel tank of a diameter to hold sufficient water (i.e., have sufficient area) to prevent the maximum vertical velocity of the water from exceeding 8 ft. per hour; (2) a central downtake tube provided inside of this tank being open at the bottom and of sufficient diameter, when considering its height that it will hold the mixture of water and chemicals at least 30 and preferably 45 minutes before the water passes out at the lower end and starts to rise upward through the annular sedimentation part of the main tank; and (3) a mixing box or similar provision installed at the top of this downtake tube for the purpose of efficiently mixing the chemicals with the incoming water. In many cases, notably as developed on the Chicago, Rock Island and Pacific by P. M. LaBach, Engineer of Water Service, agitating paddles are provided in the downtake tube.

Types of Settling Tanks

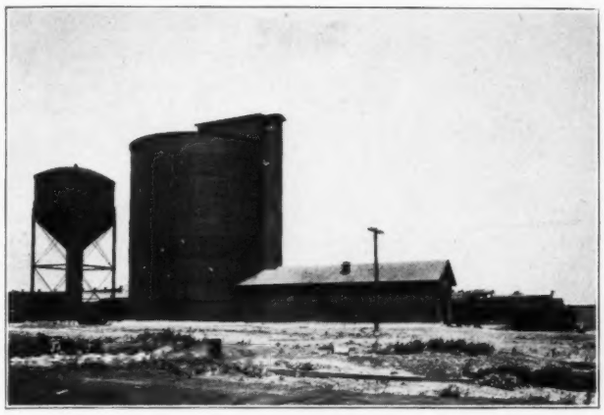
The steel tanks usually favored are the flat bottom standpipe type with a perforated pipe sludge collecting system in the bottom. The size of these tanks now in service will vary from 24 ft. diameter by 30 ft. high with 6 ft. diameter downtake tube, to 40 ft. diameter by 76 ft. high with 12 ft. downtake, the latter being installed on the Chesapeake and Ohio Railway at Stevens and Russell, Ky., Marion and Columbus, Ohio, and Richmond, Va. A tank of 62 ft. diameter by 43 ft. 6 in. high, with 16 ft. downtake tube, has been installed by the New York Central at Elkhart, Ind. Floating outlets are usually provided in the larger tanks, but with either the floating or stationary type of outlet it has been found to be good practice not to take off water at a point

New York Central R. R., Elkhart, Ind. One of the Largest Continuous Type Plants

lower than that at which the water will be retained in the sedimentation part of the tank, from the inlet upward, for at least 6 hours—and always with the provision that the vertical velocity be held to less than 8 ft. per hour.

Some railroads have favored or tried various types of cone or sloping bottom steel tanks with the thought of expediting sludge removal, but others claim that the benefit of such construction is doubtful. Most railroads

rely upon proper chemical mixture and sedimentation for clarification but in a few cases, such as on the Illinois Central, sand filters have been installed as a safeguard before delivery to final storage tank. One inexpensive arrangement consists of a 10 or 12 ft. diameter tub installed inside of the standard 16 x 24 ft. or 20 x 30 ft. roadside wood tank. The water and chemicals are mixed in a box under the roof of the tank, brought down through a flume about 18 in. square to the bottom of the inside tub from which the water flows up through an excelsior filter, usually about 2 ft. thick, near the



Chicago, Rock Island & Pacific R. R., Burr Oak, Ill. Continuous Type Plant

top of the tub. The clarified water then flows over into the storage part of the road-side tank for delivery to the engines. Concrete tank or reservoir construction has only been used experimentally at a few softening plants because the desired results can be obtained in the steel tanks at a considerably lower installation cost.

One feature of a mixing arrangement developed by the late C. Hershel Koyl merits particular attention where extraordinary means are required to overcome trouble from slow and finely divided precipitation Instead of having a mixing box at top of the tank, characteristic of the usual installation, Mr. Koyl piped the water and chemicals to the bottom of the central reaction tube in which stirring was procured by mechanical agitation, usually run by water wheel power, and the mixture taken off from the top of this reaction tank was delivered through suitable piping or troughs to the bottom of the sedimentation tank from which the clarified water is drawn off through floating outlets to the storage tank. This system combines the benefit present in the old style "intermittent" plant of mixing the incoming water and chemicals with old sludge to produce larger particles and as a result better sedimentation ensues.

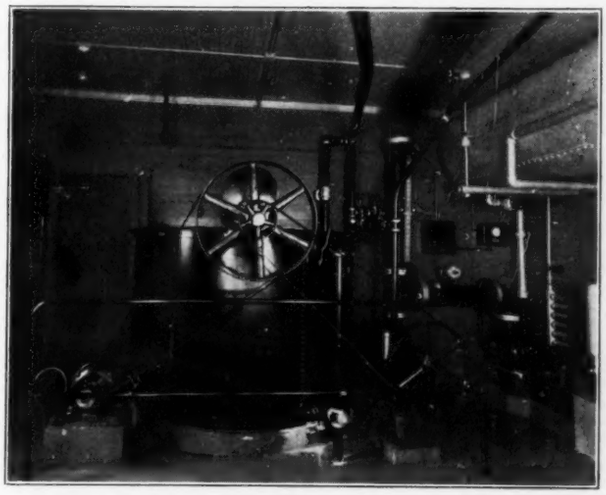
Chemical Feed Devices and Filters

There are several proportioning devices available on the market which have been found to give sufficiently accurate proportioning for dependable results if given the required attention and supervision. Most of the early "continuous" type plants had this proportioning device on top of the tank which was objectionable in that it was difficult to keep a check on the operation and make repairs. All later developments have been in connection with the ground operated proportioners and these vary from orifice, weir, or tipping bucket control to various sizes of simple displacement water engine as developed on the Atchison, Topeka and Santa Fe.

Hydrated lime and soda ash are the chemicals almost universally used because these chemicals will produce the most practical and effective softening results at least cost. Unslacked lump lime is still being used by the Atchison, Topeka and Santa Fe in accordance with their early water softener designs which include revolving slacking vats and air tight rooms for lime storage. The use of unslacked lime can be made to give the desired hydrate alkalinity at the least cost if rapid deterioration and air slacking can be prevented. Most railroads have found it more desirable and economical, however, to use the more stable hydrated lime, which permits less expensive building construction and does not require so much care in handling or storage. Standard specifications for the purchase of these chemicals have been adopted as recommended practice. The Manual of the American Railway Engineering Association contains these specifications.

Barium hydrate and barium carbonate have been given consideration at times in order to take advantage of the obvious benefit of precipitating and removing the sulphate radical which is always left in the water in the form of sodium sulphate when soda ash is employed in the treatment. The high price and low reaction value of the commercially available barium salts has, however, discouraged developments along this line. The one outstanding example of a barium salts softener in railroad service is on the Chicago, Burlington and Quincy Railroad at Edgemont, So. Dak., where an artesian well water flowing from a 3,000 ft. deep well at temperature of 120 deg. F. and containing 11.3 gr. per gal. of carbonate hardness, 12.2 gr. per gal. *non*-carbonate hardness, and a total of 58.5 grs. per gal. dissolved solids is softened to less than 3.0 gr. per gal. hardness, leaving but 25.9 gr. per gal. total dissolved solids, by treatment with barium carbonate in addition to the hydrated lime and sodium aluminate.

Only a very few water stations in railroad service employ filters for the removal of mud and sediment without further treatment or softening. Examples of such installations are the use of gravity slow sand filters in use on the Southery Ry., at Spencer, N. C., and Monroe, Va., where the coagulant is used is sodium aluminate,



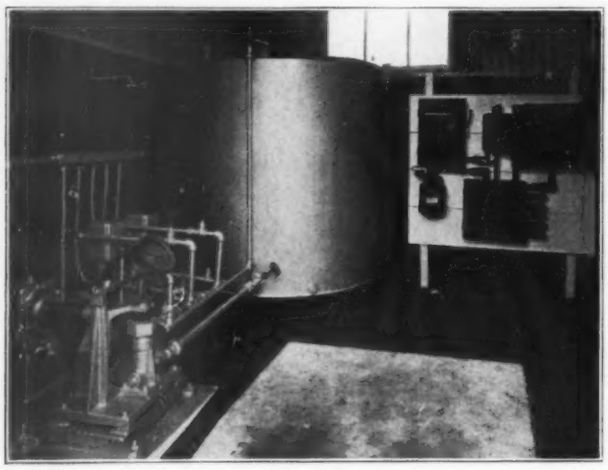
Missouri, Kansas & Texas R. R., Franklin, Mo. Sparling Meter Proportioner for Application of Chemicals

and the pressure filter installation on the Illinois Central at Baton Rouge, La. It has been found generally, that a combination steel settling and storage tank with downtake tube can be installed at no appreciable increase in cost over sand filters. By employing a softening chemical and a coagulant clarification and softening can be

obtained simultaneously with no greater expense and less maintenance trouble and a better water for boiler use is thus secured.

Coagulating Chemicals and Wayside Treatment

The development and use of coagulants has been given considerable attention in railroad water softening during the past ten years. Alum had been tried with some success at several places. Copperas seems to have been used first on a widely extensive scale by the late C. Hershel Koyl to assist in preventing after precipitation in locomotive injectors and branch pipes. The use of either of these materials is objectionable in many waters



Chicago & Eastern Illinois R. R., Yard Center, Ill. Sodium Aluminate Proportioner

treated for boiler purposes because of the increase in the residual sodium sulphate which aggravates foaming conditions and in some cases pitting and corrosion. Possibly the greatest incentive toward using a coagulant in railroad water treatment was the commercial development of sodium aluminate. In many waters, especially those at lime-soda treating plants, sodium aluminate serves better as a coagulant than either alum or copperas which react better at a lower pH value. Furthermore, the floc formation from the calcium and magnesium aluminates that are produced obviates the necessity of adding additional soda ash, which is required to neutralize the acidity of most coagulants. Curtailed use of soda ash results in keeping down the alkali salts concentration. It has also been noted that the use of sodium aluminate appears to speed up the chemical reactions and forces them to earlier completion, especially aiding in breaking up the soluble double salt of sodium-magnesium carbonate which frequently gives trouble during cold weather. Using sodium aluminate makes it easier to carry a lower hardness in the final water than was possible with the lime-soda process alone and the improved results are reflected in betterment in boiler performance. On some waters similar results can be obtained with alum but this material does not appear to have the desired flexibility in application that can be obtained with aluminate. Good results are also claimed for this material in breaking up and eliminating hard silica scale. During the past few years many installations of wayside treating plants have been made by railroads. In such plants either sodium aluminate alone or the same mixed with soda ash, caustic soda (and in some cases tannin extracts) is employed.

Probably the least expensive water treatment practice in use on American railroads as far as first cost is concerned, is the application of soda ash to each roadside tank supply in sufficient amount to neutralize the non-carbonate hardness and carry an excess sodium alkalinity of approximately two grains per gallon in the water delivered to the locomotives. This process was first developed intensively on the C. B. & Q. Ry., between 1905 and 1910 by Mr. W. A. Pownall, Water Engineer, under the supervision of M. H. Wickhorst, Engineer of Tests. Various methods are used for applying the soda ash and the amount was controlled by frequent check tests made on water samples taken from the locomotive boilers as well as wayside tanks. Experience showed that best results were secured when the excess alkalinity over the hardness in the boiler waters was maintained at not less than 15 per cent of the total dissolved solids. A small balance with an alcohol lamp and evaporating dish was part of the water inspector's standard kit used in making tests at the various terminals in order to expedite the handling of formula changes if found necessary. The method was taken to the Wabash R. R. by Mr. Pownall in 1912, and later developed with good results on the St. L. & S. F. Ry., and on the Alton. Where careful and regular check supervision is given, followed up by a well planned blow-off schedule to maintain the total dissolved solids below the critical foaming point of 250 parts per 100,000 for such treated waters, very satisfactory improvement has been made in boiler conditions. The technical reasons for this is well outlined in the excellent report by Dr. R. E. Hall on the investigation covering the physico-chemical study of scale formation and boiler water conditioning carried out at the Bureau of Mines Experiment Station, Pittsburgh, Pa., between 1922 and 1926.

Internal Treatment

The successful handling of waters of average hardness by "interior" treatment, using proprietary boiler compounds, has been reported where such treatment has been carried out and followed up under a well supervised plan for checking the treatment and results in

Pere Marquette Ry., Buffalo, Mich. Roberts Water Motor Proportioner

conjunction with a suitable blow-off schedule which will prevent excess accumulations of the solids precipitated in the boilers. It is doubtful if there are much cleaner boilers in this country than have been noted on Canadian National engines running between Sarnia and Montreal. Water used carries an average hardness of 13 grains per Imperial gallon and receives compound treatment under the supervision of terminal boiler inspectors who

are equipped with test kits and control the addition of compound by alkalinity determinations at the end of runs. The three companies which have supplied the large majority of the proprietary compounds for railroad water conditioning are the Dearborn Chemical Co., The Bird-Archer Co., and the Paige-Jones Chemical Co. The Dearborn and the Bird-Archer Companies have specialized largely on "interior" treatment methods where the addition of chemicals has been made direct into the locomotive boilers after washouts, or else at regular intervals into the locomotive tenders. In special cases, however, treatment has been made at the roadside tanks. The Paige-Jones method has been to feed the compound through bypass feeders direct into the water going to the roadside tanks. The ordinary compounds used contain principally soda ash or caustic soda, together with various forms of tannin which delay the reactions in the cold and are supposed to prevent trouble from scaling of the exterior water lines and with aiding the floc formation during precipitation under pressure in the boilers. In many cases the direct "interior" treatment, tri-sodium phosphate is used with the other materials, and in some instances sodium aluminate, sodium chromate, graphite, and mercury. "Anti-Foam" compounds have been used advantageously in a number of highly mineralized sections where a mixture of castor oil emulsified with tannins and colloidal materials such as starch or dextrose have the property of mixing with the cold water in the engine tenders and tend to break up the formation of froth or foam in the hot boiler water within their concentration working limits.

Progress Made Since 1904

An interesting check-up of railroad water treatment progress appears in the annual reports of the Water Service Committee of the American Railway Engineering Association. A survey made in 1904 indicated that there were 257 water treating plants in service on American railroads at that time, the majority of these being constructed since 1900. Another report made in 1918 gives an estimate of 550 plants treating about 8 per cent of the water used for steam purposes. At the present time it is estimated that there are about 1,200 complete lime-soda plants treating 90 billion gallons annually, 650 soda ash or sodium aluminate wayside plants treating 15 billion gallons, 350 plants using compound treating 18 billion gallons, and 95 zeolite plants treating 12 billion gallons of water. This is a total estimate of 135,000,000,000 gallons of water receiving treatment annually on American railroads, representing approximately 40 per cent of the water being used for steam purposes. This would indicate that there still remains opportunity for further progress in this line of development and as the power units become larger and demands for economy more exacting, continuously increasing attention to water treatment problems will be required.

Pioneers and Progress

Before closing it is fitting to call attention to the work and scientific contributions made to the development of these economies in railroad operation. In addition to the late C. Hershel Koyl, who started water softening on the Rio-Grand Western in the early 90's, later equipping the Great Northern and also the Chicago, Milwaukee, St. Paul and Pacific, special mention should be made of the work done by W. A. Powers, former Chief Chemist of the Atchison, Topeka and Santa Fe, who developed the method of continuous treatment used on that railroad, having 65 plants in service at time of the report of 1904 and approximately 160 at the present time. Mr. G. M. Davidson, formerly Engineer of Tests on the Chicago and Northwestern was also one of the early investigators who produced results as was also Mr. M. D. Miller, former Superintendent of Water Service on the Missouri Pacific. The water treatment on the Norfolk and Western has shown steady progress since 1905 under the direction of J. H. Gibboney, Chief Chemist, and the correction of water problems since 1912 on the Union Pacific under the direction of Dr. W. M. Barr, Assistant to Vice-President, has been especially creditable. The greatest single development in water softening during recent years has taken place on the Baltimore & Ohio R. R. where 113 plants have been installed and operated under the direction of C. P. Van Gundy, Engineer of Tests, and the annual saving is reported to be over $1,000,000.

Drinking Water Problems

One feature of the railroad water service which is of minor importance from a monetary standpoint but often proves most troublesome, is the furnishing of drinking water to comply with the Interstate Quarantine Regulations. The usual practice where suitable water can be purchased from a municipality, is to arrange for such supplies. However, there are still, unfortunately, several municipal supplies which do not meet the requirements and where even a provisional certificate has been refused by the State and Federal Authorities. In such cases it becomes necessary to either haul drinking water from an approved source or arrange for treatment of the local supply. Drinking water is frequently required on railroads where municipal supply is not available. As the use of such water is confined to comparatively small and irregular amounts, suitable chlorination offers various problems. At some points stills have been installed. One method which has given positive and satisfactory results is the use of the water from lime-soda softening plants. In the operation of such plants it is necessary to maintain an excess of caustic soda alkalinity in order to attain satisfactory boiler conditions. The retention period is at least four hours and usually over six hours. As the limit of tolerance for typhoid bacilli is pH 8.7, the carrying of this water at pH 10 or over for four hours entirely eliminates B. Coli and other gas formers. Careful check tests have been run on samples of the softened waters on the Chesapeake & Ohio Railway in several states with the cooperation of the respective State Boards of Health. The bacterial count has been unusually low and no B. Coli present in 50 c.c. samples. The slight causticity has had no apparent ill effect on persons using such supplies over a 10 year period and at no time has any typhoid case been traced to the use of such water, this notwithstanding the fact that the Ohio River is the source of supply at two points and other supplies are from surface streams with heavy pollution in the raw water. Where the slight caustic taste has proven objectionable or caused complaints, small pressure filters are used with pre-alum treatment which removes the causticity. Although there has been some hesitancy in a few cases to consider such treatment favorably due to lack of bacterial check and control, such hesitancy does not appear to be warranted as it is necessary for the railroad chemist to see that this caustic alkalinity is maintained in the water going to the boilers in order to produce the results which justify his position, and with this alkalinity, freedom from injurious bacteria is assured.

With any kind or type of water treatment, competent supervision and check is necessary to produce and insure results. Automatic machinery is only automatic when it is kept working properly. Chemicals must be added

regularly and applied properly in predetermined amounts which requires qualified check tests. Definite responsibility must be given the plant operators and also the supervision. The best mechanical facilities will function only in a perfunctory manner or fail entirely if not followed up by a careful check system, and it has been found that an organization with definite responsibilities is the first essential to successful railway water service operation.

Errata Noted in Our December Issue

[In the article by Mr. Bardwell in our December 1932 issue, the word "million" was inadvertently omitted from the last sentence in paragraph one on page 403. Movement of rail traffic in normal times will amount to 1,000,000 *million* gross ton-miles annually, rather than the mere 1,000,000 ton-miles as printed. We also desire to correct an error in illustration captions. The plant shown on page 404 is located at Proviso, Ill., and not at Russell, Ky. The pump-well shown on page 405 is located on the Chesapeake and Ohio Railway at Russell, Ky. We regret extremely that such errors escaped our proof reader's notice.—Editor.]

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Michigan Purification Men Hold Seventh Annual Conference

The Seventh Annual Conference on Water Purification was held in Mt. Clemens, Mich., in October, with Mr. Roberts Hulbert of Detroit presiding and Messrs. Anthony Keils, superintendent of water works, and Harry McEntee, filtration superintendent, as hosts to the eighty-eight members and guests.

A feature of the meeting was the number of opportunities given for informal discussion and relation of experiences which is always valuable to water works operators. In addition to the Round Table topics discussed a "Question Box" was held and this feature proved very worthwhile.

Digest of the More Important Papers Read

"The Hydraulics of Rapid Sand Filters," by Messrs. Hulbert and Feben of Detroit.

The authors called attention to the pitfalls and errors which may be introduced by specifying sand for rapid filters on the basis of effective size and uniformity coefficient alone. A new formula has been developed for determining the loss of head through filter sand which is based on a sieve analysis and the determination of a porosity factor. Mr. Arthur Morrill, of Detroit, selected one of the sand analyses given in the paper and demonstrated the calculated loss of head for that sand. He called attention to the great value of being able to predict such characteristics of sands.

"What Price Wash Water," by Ralph Hoot, Public Service Engineer of Detroit.

The author stressed an item of plant operating cost which filter operators have practically disregarded. Instead of striving for low wash water volumes they were cautioned to become wash water *cost* conscious. He said that wash water should not carry a portion of salaries, general plant maintenance and general supplies. Its sole cost was the cost of pumping and chemical treatment alone. In the last analysis the cost of wash water was so low that even if the percentage used were doubled or tripled the cost would be insignificant. The sum and substance of Mr. Hoot's remarks was—Why skimp in so essential a thing as wash water?

"Studies in Sterilization with Chlorine," by Prof. W. L. Mallmann of Michigan State College, East Lansing, Mich.

Dr. Mallmann's discussion of sterilizing effects of chlorine as influenced by variable pH values was a summarization of an article by the author which appeared in the July, 1932, issue of the Journal of the American Water Works Association.

He then reported on a recent comparative study of the speed of action of chlorine vs. chloramine. In a series of laboratory experiments he had been able to show that by varying the pH it was found that chlorine and chloramine could be made to produce practically identical rapidity of sterilization. Consideration of the pH value of the medium is therefore of prime importance in determining the proper chlorine dosage to employ in all cases.

In carrying out the above studies part of the work was done at swimming pools where temporary laboratories had been set up so that pool side testing could be compared with the regular laboratory tests. It was found that (immediate) testing showed a lower degree of disinfection than did duplicate samples held for laboratory examination, thus indicating the importance of the time factor in disinfection and the need for improved technique of sampling and testing. Data obtained in pool side testing showed that a polluted pool carrying a chlorine residual will sterilize itself in from 10 to 15 minutes after the bathers have left.

He described sampling procedure that had been developed to stop disinfection action at the instant of sampling. To each sample bottle before sterilization (by steam under pressure) was added a small crystal of sodium thiosulphate. When chlorinated water was introduced into such a bottle the germicidal power of the chlorine was destroyed and the bacteria left free from further destruction during transit or storage of samples. The picture obtained from such samples had represented the true condition of the water at the time of sampling. The same general condition had been found to apply in connection with chlorinated samples of public water supplies and therefore for an accurate picture of the condition of samples, at the point and instant of sampling, he felt that thiosulphate should be used to stop chlorinating effects in the bottle during transit.

Mr. Hepler, of the State Department of Health, recounted two interesting and unusual phenomena which he had encountered during the past year.

A Michigan creek turning red in midsummer had created newspaper comment and quite a little excitement. Looking into the occurrence proved this phenomena to be caused by a heavy growth of chromogenic bacteria of the variety prodigiosus. Similarly a lake turning pink had been caused by a rapid development of oscillatoria prolifica.

New officers:

Chairman—Paul Stegeman, Superintendent of Filtration, Midland, Mich.

Vice Chairman—R. A. Hoot, Public Service Engineer, Detroit, Mich.

Secretary—J. M. Hepler,* State Department Health, Lansing, Mich.

Members of Executive Committee—Roberts Hulbert and H. T. Campion.

*WATER WORKS AND SEWERAGE is indebted to Mr. Hepler, Secretary of the Michigan Conference for an excellent account of the meeting, from which the above has been taken.

The Natural Bridge, Near Staunton, Va. (The work of a Small Stream on Limestone Formation)

MEETING OF VIRGINIA WATER AND SEWAGE WORKS ASSOCIATION

(Concluded)

LACK of space in our December issue prevented completion of the digest of papers read before the Virigina Water and Sewage Works Association which met in Staunton, Va., on November 14th and 15th. The following constitutes the highlights of some of the papers read and comments by discussors.

E. H. Ruehl, Town Manager, Bluefield, Va., and Vice President of the Association

Symposium on Water Supply Derived from Deep Wells

"Construction of Drilled Wells for Municipal Supplies" by CHAS. F. COLE, President, Virginia Machinery and Well Company, Richmond, Va.

Mr. Cole discussed the preferred types of casing and methods of installing it in drilled wells. His preference was for wrought iron. Discussing deep well pumps he pointed to the value of the centrifugal type over others where it could be used in the larger wells. As to the size of the well, his experience indicated that a 12 in. well will yield 25 per cent more water than one 10 in. in diameter. In determining accurately the yields and draw down of wells, he stressed the importance of testing for a 12-hour period after the static lead had been pumped off. Disinfection of new wells was of importance and a hypochlorite powder—"H.T.H."—had proven a very satisfactory material for that purpose.

"Success in Obtaining Water Supply from Drilled Wells" by GARLAND SYDNOR, Sydnor Pump and Well Company, Richmond, Va.

Mr. Sydnor said that approximately 20 per cent of the water supply in Virginia was derived from wells—those in the coastal plane being the most important, many of which were flowing wells. One at Franklin, Va., had been free flowing at the rate of 300,000 g.p.d. and had a pumped yield of 1.7 m.g.d. From 25 municipal wells in the Coastal section the average yield had been 201,600 g.p.d., the average depth being 344 feet. In the Piedmont section of the state, underlain by granite mostly, well yields had averaged only 98,000 g.p.d. In the Appalachian section, underlain with limestone, shale and slate, average yields had been 290,000 gals. per day upwards and depth averaged 449 feet. Due to the effect of the drought on surface supplies many towns had been forced to put down wells to relieve water shortage. Alexandria had been obliged to put private wells to use, taking 648,000 g.p.d. from these; Crewe, Va., had had to return to wells to supplement its surface supply.

W. C. COCKE, Town Manager of Manassas, Va., in discussing the two above papers, told of his experiences at Manassas with pumping. The air lift system had annually created a deficit of something like $7,000 in the water department. Replacement of the air lift with deep well pumps delivering water against a total head of 400 ft., inclusive of a 70 ft. lift, had resulted in an annual saving of $9,000 per year.

A. L. MEISEL, City Manager of Williamsburg, Va., told of their experiences with two wells 10 in. diameter, the yield of 500,000 gals. per day being sustained and the revenue considerably more than paid water works operating costs.

S. B. PARRISH, Superintendent of Public Works at Martinsville, Va., called attention to a scheme they had hit upon to eliminate purchase of soda ash to bring up the pH value of the coagulated water. An old drilled well at the filter plant had been drawn on for 135,000 g.p.d. to mix in with the surface water—that being sufficient to obtain the required alkalinity for best coagulation. Pumping the alkaline water had been cheaper than

purchase of alkali. In addition dry feeders were unnecessary and the well served as a solution tank that never ran dry.

Water Supply for Industrial Usage

"Industrial Utility of the Surface Waters of Virginia" by W. D. COLLINS, Chemist in charge of Water Quality Division, U. S. Geological Survey, Washington, D. C.

H. W. Snidow, Engineer, Virginia State Department of Health; Secretary of the Association

W. D. Collins, U. S. Geological Survey, Washington, D. C.

Anyone who has heard Mr. Collins lecture on water quality, demonstrating his remarks so effectively, realizes that justice can not be done in reporting so instructive a talk in cold type. He said that in sampling streams or municipal water supplies they had found that a composite made from 10 daily samples had proved sufficiently representative. By picturization he showed the variations in water quality in the important rivers in Virginia and discussed each from the standpoint of hardness, and corrosiveness. The results of the Virginia studies, he said, were now available in booklet form published by the Virginia Conservation Commission. Mr. Collins said, that a study had been made of water quality in more than 600 American cities to date and that reports were available to those interested.

DR. A. C. BEVAN, State Geologist, in discussion presented the relationship between the geological formations and water quality in Virginia and said that he had found it very difficult to forecast ground water yields in the state.

R. C. Bardwell, Superintendent of Water Supply, Chesapeake & Ohio Ry. System, Richmond, Va.

R. C. BARDWELL, Superintendent of Water Supply of the Chesapeake and Ohio Railway, discussed the effects of water quality on industrial boiler operation. He referred to the increasing demand for better quality of water for steam generation and even in Virginia, where water quality had formerly been considered satisfactory, a demand for improvement by treatment had now arisen. To prevent sulphate scale formation it had been shown that an excess of carbonate of soda, amounting to 15 per cent of the total solids content must be maintained in the water *inside of the boiler* at all times—soda ash being used for the purpose.

PROFESSOR F. H. FISH, of the Virginia Polytechnic Institute, said that his laboratory had made 200 mineral analyses of water supplies in Virginia and a bulletin covering the chemical quality of Virginia waters was in the making. In reply to a question concerning the effect of dissolved zinc on the human system he said that some consumers could stand 30 parts per million, but to others 5 parts would be injurious.

Paints for Water Works and Sewage Treatment Plants

During the "Question Box" hour one of the topics discussed was **"What are the most satisfactory paints for Water Works structures?"**

M. C. SMITH said that at Richmond they had experimented and had found Masury's Turpentine Asphaltum paint very satisfactory. It had stood chlorine very well also.

L. H. ENSLOW called attention to the rapidly increased use of aluminum paints. They were not only resistant to corrosion and tarnish but were attractive in appearance. A highly resistant product, carrying the trade name "Intertol" was now available in several colors in addition to the original black. Aluminum "Intertol" contained the powdered metal which automatically came to the surface after applying it and when dry possessed an aluminum exterior. Around sewage plants aluminum powder added to spar varnish had been found to be highly satisfactory and also added attractiveness to the plants' appearances. It had stood up well against hydrogen sulphide gas and other corrosive gases.

D. W. STUBBLEFIELD, General Manager, Belle Alkali Works, Charleston, W. Va., said that so far as chlorine resistance was concerned he could vouch for aluminum paint. After considerable experimentation they had settled on aluminum paint as the most satisfactory protective coating for use around their chlorine plants. He said that it would be noticed that most metal chlorine containers were now being painted with aluminum and that the pleasing appearance as well as its resistance to corrosion had been the two reasons for selecting it.

[NOTE—In a subsequent letter from Mr. Stubblefield he recommends for outside work an initial coat of red lead in linseed oil, followed by one or two coats paint made from aluminum powder costing 40c per pound mixed into the aluminum vehicle, costing about $1.17 per gallon (probably a spar varnish), which had been procured from the American Varnish Company. If the aluminum paint is to be applied with a spray gun it seemed best to add a little turpentine to the red lead in linseed oil to produce a non-glossy surface. For the maximum resistance to acids and chlorine gas, an aluminum paint bought under the trade name "Elastikote" had been found to stand up extremely satisfactorily during more than a year of exposure to chlorine gas at their Belle, W. Va.,.plant.—Editor.]

Sewerage and Sewage Treatment

"The Sewage Treatment Plant at Winchester, Va.," was briefly described by P. P. PILCHER, City Manager of Winchester, Va., who also recounted some of the operating experiences including the difficulties created by introduction of wastes from apple canning and apple products plants. He said that the foaming and odors created by such wastes entering the Imhoff tanks had been alleviated considerably by the application of lime to the sludge compartment and chlorinated lime to the incoming sewage.

In discussion, F. J. SETTEE, Professor of Sanitary Engineering at the Virginia Polytechnic Institute, reviewed their experiences with Imhoff tanks, contact beds and sludge drying under glass covers at Blacksburg. He felt that the sludge capacity in their Imhoff tanks should be 2.93 cu.ft. per capita and that the 2 cu.ft. allowance usually considered as sufficient was not enough. The digested sludge there usually contained 56 per cent of volatil solids—also considered to be higher than normal. Such sludge required 30 days to dry on glass covered beds. With increasing experience with the behavior of Imhoff tanks he felt more and more favorable toward separate sludge digestion practice and believed that sludge digester capacity should be determined only after a test had been made to determine the moisture content of the digested sludge. The latter would prove to be the criterion in the design of digestion tanks and drying beds. In reply to a question Professor Settee said that he did not consider that the sewage treatment problem had been solved and considerable progress could and probably would be made in the near future. For the time being he preferred the activated sludge process to sprinkling filters but for small towns he considered that separate sludge digestion with chlorination and sprinkling filters as the oxidising device remains as the most practical methods of treatment.

J. A. NOLL, Superintendent of Public Works, Harrisonburg, Va., in commenting on the Imhoff tanks constructed in Harrisonburg in 1916 stated that they had always given satisfaction. Industrial wastes from a tannery, milk plant and silk mill had given them trouble in years gone by. He expressed his appreciation of the assistance rendered him by the engineers of the State Department of Health.

STIRLING WILLIAMSON, City Engineer of Charlottesville, Va., reported on operating results at one of the

Stirling Williamson, City Engineer, Charlottesville, Va.

H. B. Rice, Superintendent Water Works, Staunton, Va.

two Imhoff tank plants at Charlottesville. The tanks had removed 89.5 per cent of the settleable solids. The moisture content of the digested sludge had varied between 80 and 88 per cent, the 12 month average being 84.5 per cent. The volatil matter in the digested sludge had been surprisingly low, averaging 27.6 per cent, and the pH value averaged 6.8 with a low in Winter of 6.5. Gas production had been slightly under 1 cu.ft. per capita. Although average air temperatures during the months of July and August had reached 96.5° F. the temperature of the sewage had not exceeded 79° F. The sewage is prechlorinated during the Summer for odor control and improved plant efficiency.

L. H. ENSLOW said that he wished to extend his compliments to Mr. Noll at Harrisonburg and Mr. Williamson at Charlottesville for the excellent attention given the operation and maintenance of their respective plants. The records at Charlottesville, as supported by data, spoke for themselves. At Harrisonburg the Imhoff tanks had functioned properly because of the conscientious care given them in routine operating procedure. As a former engineer of the Virginia State Department of Health he had found Mr. Noll always ready to have done whatever was needed to keep the plant in efficient condition and pleasing to the eye. Dropping in at odd times, he had always found the attendant busy and a jump ahead of the sludge and scum problem. The results spoke for themselves and indicated what could be accomplished regardless of the limited gas vent area and other circumstances calculated to upset the digestion of anybody's Imhoff tank.

Editor's Note—It leaked out at this meeting that Willard F. Day, President of the Association and City Manager of Staunton, Va., had been recently elected First Vice-President of the International Association of City Managers.

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Canadian Sewage Works Association To Be Formed

A number of municipal officials met at the Royal York Hotel, Toronto, Ont., on Dec. 14th, at the request of the Ontario Department of Health. The meeting was called for the purpose of discussing the organization in Canada of some group which would be interested in sewage treatment and allied subjects. Representatives were present from several municipalities in Canada, to the total number of nearly 30. After a thorough discussion it was decided to organize and an executive committee was appointed to draw up a constitution, and to deal with such matters as a name for the organization, fees, date of convention, affiliation with other groups, and allied subjects.

It was agreed by the meeting that the new association should interest itself primarily in sewerage matters, and such other related activities as may from time to time be decided upon. From the interest manifested at this meeting there is reason to believe that this new organization will find a valuable place in Canada, and that regular conventions will be a feature, with representation from those interested in the design, operation or administration of sewerage works and other sanitary works apart from waterworks systems.

Mr. R. C. Harris, Commissioner of Works, Toronto, was elected Chairman of the Executive Committee; W. M. Veitch, City Engineer of London, Ont., was named as Vice-Chairman, and A. E. Berry, Director of the Engineering Division of the Ontario Department of Health, is Secretary-Treasurer.

It is probable that the Canadian Association will affiliate with the Federation of Sewage Works Associations of the U. S. A.

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DDLINQUENT WATER BILLS.—Delinquent water bills should be carefully weighed against the health hazard of water deprivation before closing the valves.—*Ohio Health News.*

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THE FAMILY UNIT—The American "family unit" is growing smaller. According to the census of 1890 it consisted of 4.93 persons. In 1900 it was found to average 4.60 persons and the enumeration of 1930 records it as down to 3.81.

MEETING OF NORTH CAROLINA SEWAGE WORKS ASSOCIATION

IN our December issue there appeared a report covering the meetings of the North Carolina Section of the A. W. W. A., and the North Carolina Sewage Works Association, held at Winston-Salem, N. C., on November 1st and 2nd, 1932. This report embraced a digest of the papers presented on water supply and water treatment, but lack of space prevented the inclusion of the following papers read which dealt with sewerage and sewage treatment.

An illustrated paper describing **"The Dearborn Michigan Sewage Treatment Plant and its Operating Results,"** was presented by MARK B. OWEN, Superintendent of Public Works, Dearborn, Michigan.

Mr. Owen reviewed the results secured from a small experimental sewage treatment plant employing chemical precipitation, chlorination and straining of the effluent through a Laughlin electrically-operated, self-cleaning, upward flow filter containing crushed magnetite ore. On the strength of the experimental plant results a large plant had been designed and built to serve 159,000 people residing in Dearborn and a section of Detroit.—(See WATER WORKS AND SEWERAGE for October, 1931, for a description of the Dearborn plant.)

Mr. Owen said that the new plant had been operating for something more than six months, representing a period of large scale experimentation to evolve the most effective and economical methods of operation. After trying various procedures and coagulants they felt that the use of burnt lime, paper pulp and ferric iron salts had given the best results. The early practice of adding the septic sludge from the old plant (pumped through an 8-in. cast-iron force main 19,900 ft. long) to the fresh sewage received at the new plant had been unsatisfactory and would be abandoned. The sludge would hereafter be coagulated and settled in one clarifier and the sewage proper would be coagulated and settled in the other clarifier. Such practice had produced more uniform and dependable results.

While they had manufactured a considerable quantity of ferric-chloride by chlorination of scrap iron in two towers in series, they had also used ready prepared ferric-chloride solution (42 per cent $FeCl_3$ content) and "Calcoag"—the latter containing a high per cent of ferric sulphate. The use of high grade lime had proven superior to the lime bearing sludge, constituting a waste product, from acetylene gas manufacture. Recent results had shown it possible to produce an effluent with a 5-day oxygen demand of between 18 and 24 parts per million when using lime, paper pulp and ferric chloride in coagulating the sewage containing no septic sludge. Sludge and sewage mixed had been reduced from an initial of 668 p.p.m. B.O.D. to 58 (averages) in the effluent. The Laughlin travelling automatic bar-screen had been entirely satisfactory and the Laughlin Magnetite Filter, operating at a rate of upward flow of 2.15 gallons per minute per square foot, had surpassed the manufacturer's guarantee and had given little or no trouble. The ferric chloride requirement had varied between 11 and 68 parts per million (expressed in terms of $FeCl_3$)—the average being 38 parts per million. The lime dosage would average about 300 lbs. of commercial lime to each million to produce an effluent averaging 8.5 in pH value.

Sludge dewatering on vacuum filters had been satisfactory, producing from the sludge, carrying 89 per cent water, a filter cake carrying 57.5 per cent water. The cake had dried without nuisance when spread on land. The capacity of the filters had been 4 lbs. of dry solids per hour per square foot of filter area.

In commenting on costs, Mr. Owen said that due to the peculiar manner of handling sludge settled from 4 million gallons of sewage and later added to only 1 million gallons of sewage as such, a representative picture based on costs per million gallons treated could not be presented. Over a five-month period the average cost for removal of each pound of 5-day oxygen demand from the mixture, had been $2.15. The practice of segregating sludge and fresh sewage for separate treatment will decrease the chemical cost.

In reply to questions, Mr. Owen said that the magnetite used in the Laughlin filter was three inches deep and was of a size to pass a 10-mesh screen and be held on a 16-mesh; it costs $15.00 per ton. Operating for a time with high lime dosages to produce pH values of 10 to 11 in the effluent had caused clogging of the metal filter screen beneath the magnetite, necessitating removal by acid treatment.

"Sewage Works Financing" being a matter of increasing importance was gone into with thoroughness by C. W. SMEDBERG, Director of Public Works at Greensboro, N. C.

Mr. Smedberg said that, basically, financing of operation of sewers and treatment works should be met through money derived through an apportionment of costs based on actual service rendered each user. He then discussed several methods of financing, pointing out the good and poor features of each. A combination of assessment based on property value (or area) and a rental charge, comprising a ready-to-serve charge plus a charge based on water consumed, seemed the most equitable and practical scheme considered. He thought that the strength as well as the volume of sewage would eventually be given weight in a rate scheme also. Enabling Acts in 20 states, he said, had allowed 107 municipalities to apply a rental charge for sewerage, but in North Carolina only a few of the larger cities could legally apply the rental system. Charlotte and Greensboro had employed a combination assessment based on area and value of property served. Winston-Salem assesses on the property valuation basis and adds to the water bills a sewer rent (10 per cent to water bill) for paying operating costs. The rental method had gained popularity rapidly and when applied in addition to a ready-to-serve charge, based on property valuation, it appears to be the most practical scheme of financing sewerage as evidenced by experiences.

C. W. Smedberg, Director Public Works, Greensboro, N. C.

"The First Year of Sewage Treatment Plant Operation—The Hardest" by A. R. HOLLETT, Superintendent of Sewage Treatment, Chapel Hill, N. C.

Mr. Hollett described the revamped sewage treatment plant at Chapel Hill, N. C., which now employes the old Imhoff unit equipped with a welded steel cover, as a separate sludge digestion tank. A Dorr clarifier, a gas holder and chlorinating station had been added to modernize the plant to produce highly satisfactory primary treatment. Such treatment with chlorination during low stream conditions had been all that had been required. The cost of operation had amounted to but $9.00 per m.g. and adding bond interest of $8.51 gave a total cost of $17.51 per m.g. The new work and equipment had cost $29,117.00.

Mr. Hollett enumerated some of the happenings common to new sewage treatment works which make life miserable for the operator, the designing engineer and the superintendent. Violent foaming had been experienced but not until the gradual accumulation of scum in the converted Imhoff tank digester to a depth of 11.5 feet had raised and actually ruptured the steel cover weighing 19 tons. During the past 4 months (up to October, 1932) the plant performance had apparently reached equilibrium, producing gas at the rate of 1 cu. ft. per capita. That had come about only after 7 months of operation, notwithstanding the artificial heating and pH adjustment of the sludge. After 3½ months of operation gas production had not started until the temperature in the digester had reached 78 F. and even now at the maintained temperature of 85 F. the gas (1 cu. ft. per capita) contained but 67 per cent of methane.

J. S. Whitener, Professor of Sanitary Engineering, North Carolina State College

The clarifier operation had been very satisfactory considering the fact that solids were allowed to accumulate between operations of the scraper mechanism twice daily. The removal of settleable solids had averaged 93.8 per cent and the reduction of oxygen demand had been 41.3 per cent, before chlorination.

During hot weather odors around the plant had been controlled by prechlorination of the crude sewage, employing roughly 12 parts per million of chlorine to maintain a residual in the clarifier effluent. Chlorination of the clarifier effluent employed during the summer, to reduce its oxygen demand, had produced results as anticipated and the lowest dissolved oxygen content of the receiving stream, at its critical point in hot weather, had been 2.46 p.p.m.

In reply to a question, Mr. Hollett said that the Chapel Hill sewage was rather high in grease content because of absence of grease traps on the system. Experiments had shown that 81 per cent of this grease could be removed by diffused air aeration but for the present such was not considered necessary.

Sewage Chlorination Improves Stream Conditions

"Some Effects of Sewage Chlorination on the Receiving Stream" was the subject of a paper read by H. G. Baity, Professor of Sanitary and Municipal Engineering, Chapel Hill, N. C.

Professor Baity presented the findings of extended investigations of stream conditions before, during and after chlorination of the sewage passing through the Chapel Hill treatment plant. Such studies, covering a period of 4 years, had represented the first attempt to correlate laboratory observations, indicating that chlorination reduces the oxygen requirement of sewage from 25 to 40 per cent, with actual changes in stream conditions brought about in practice. The drought of 1930 had given them sustained constancy of a limited stream flow and continued high temperatures so desirable in making conclusive the studies conducted at Chapel Hill intermittently since 1928. From the 111 days of observations along a 4-mile stretch of sluggish stream, representing a flow time of several days in dry weather, the results had been sufficiently convincing to warrant the statements; that the visible appearances of the stream were markedly improved in that slime growths and black deposits had disappeared, revealing a clean bottom. Turbidity had been reduced and stream odor had been improved materially. The slime growths, odor and turbidity had reappeared upon discontinuance of chlorination.

A study of the oxygen balance in the stream had shown a marked improvement in that direction. The dissolved oxygen content of the stream had been increased by 140 per cent or better at the critical point 3,000 feet below the plant where the per cent saturation had averaged 54 as against 22 after chlorination had been discontinued at intervals for the purpose of comparing conditions. At the one-mile station down stream the per cent saturations during and after chlorination were 35 and 26 respectively, and at 4 miles down the values became 54 as compared with 51. The B.O.D. (5-day) values of stream samples had shown that a 14 per cent reduction had been created by chlorination on the average at the station 3,000 feet down stream. Higher up stream the reduction amounted to 57.5 per cent whereas 4 miles down stream the reduction observed was of no consequence (4 per cent) because the stream had recovered to an extent that the oxygen demand was approximately 3 parts per million without chlorination and the same during chlorination.

H. G. Baity, Dean of Engineering, University of North Carolina and Secretary of the Association

The observed 25 to 40 per cent reductions of the 5-day B.O.D. value of the sewage by chlorination, in the opinion of Professor Baity, had been confirmed as an actual reduction for the most part, as evidenced by the dissolved oxygen and oxygen demand relationship in the stream proper. That the marked difference in the stream immediately below the plant had been created by retardation of biological activities and that the sustained but less marked differences lower down had been due to an actual and permanent reduction of oxygen demand, seemed to Professor Baity to be shown by the accumulated data and had been amply supported by actual observations of stream conditions.

During the series of observations in 1930 the stream flow had been rather steadily 443,000 g.p.d. and the input of settled sewage had been 299,000 g.p.d. on the average, representing a dilution of roughly 1.5 to 1. The chlorine demand of the effluent had been approximately 12 parts per million and the B.O.D. value before chlorination had averaged 113 parts per million.

L. H. Enslow said that anyone who had dealt with stream studies would appreciate the reason why Pro-

fessor Baity had questioned the Chapel Hill observations during the three years prior to 1930. The weather changes had created altered stream conditions between periods of chlorination and no chlorination which made it hazardous to draw conclusions concerning the true effects of chlorination of the sewage effluent. By good fortune the sustained hot, dry weather of 1930 had made conditions for the continued studies about as nearly ideal as were to be found at any place in the country. The conservativeness of Professor Baity had made the final draft of conclusions all the more valuable and he wished to say that the Chapel Hill studies represented the only truly valuable contribution yet made concerning the real effects of the chlorination of sewage effluents on stream conditons. It had been only through the "never give up" spirit of Professor Baity and his co-workers that the studies had been continued at intervals during the four-year period hoping to reach definite conclusions. The work constituted an original investigation, the results of which should prove of considerable value to engineers and municipalities faced with the problem of providing a somewhat higher degree of sewage treatment than sedimentation or chemical precipitation can produce alone.

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Water Works Improvements Can Be Made at Low Cost

Water systems of the municipalities in Ohio are, almost without exception, on a sound financial basis. Even in these times, when other branches of municipal activities are hampered by lack of funds, the water works departments are operating within their incomes and are meeting all their obligations.

There is hardly a city or village in the State where improvements to the existing water works systems are not needed. Extensions and reinforcements to the water distributing system are needed in almost every city and village as evidenced by the poor pressure existing every summer during a fire. Elevated tanks or reservoirs to store water on the distributing system are needed to relieve pumping peaks and to provide better pressures.

There are about 400 municipalities in Ohio served by public water supply systems. About 100 of these municipalities supply to their consumers water which has an objectionable iron content that causes staining of plumbing fixtures and makes the water undesirable for laundry purposes, and these municipalities need iron-removal or combined iron-removal and water-softening plants in order to deliver a satisfactory product to their customers. More than two-thirds of the water works in Ohio deliver a water that is too hard for domestic uses, and these municipalities need water-softening plants. At many cities and villages important improvements are needed to remedy defects which constitute hazards to the safety of the water supply furnished to the public.

At the present time there is an increasing interest in the construction of public works to help solve the unemployment situation. Water works improvements offer a much better investment than most of the unprofitable and in many cases unnecessary projects which have been carried on during the past year to provide labor for the unemployed. From the standpoint of construction costs, the present time is more favorable for the construction of improvements than any time since 1913.

The financing of waterworks improvements depends on local conditions. A few municipalities have a surplus in the waterworks fund which can be used for improvements, but most municipalities would have to sell bonds to finance any extensive betterments. Even with the limits established by statute on the amount of bonds that can be issued, many municipalities have considerable leeway to finance waterworks improvements without the necessity of submitting the question to a vote.

Where bonds cannot be issued and where the interest and sinking fund therefor cannot be obtained without embarrassment to other necessary municipal activities, the financing of improvements by "waterworks bonds" should be considered. Such bonds are secured against water revenues and not against the tax duplicate. The Reconstruction Finance Corporation is ready to loan money for self-liquidating projects, and loans for waterworks improvements have already been granted in Ohio to Conneaut and Sandusky. Frequently existing rates are sufficient to produce the necessary revenues to pay for such loans. In some cases an increase in the water rates of a few cents per thousand gallons would be sufficient to finance the improvements. The improved service or the improved quality of the water delivered to the consumers would justify the slight increase in water rates.

Municipal officials would do well to consider that now is the time when water improvements can be installed at lowest costs, that now the labor required would receive the most benefits, and that means of financing *can be provided.* Municipal officials are therefore urged to look over their waterworks systems and to undertake needed improvements at this time.—*Ohio Health News,* Ohio State Department of Health, Dec. 15, 1932.

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Financing Sewer and Waterworks Simplified

Both Kentucky and Alabama have recently adopted laws which permit municipal water and sewer systems to be financed on a "self liquidating" basis. Cities in these states may operate such works as public utilities, collecting service charges from users, instead of receiving support from general taxes. This plan of financing enables the projects to qualify for R. F. C. loans to be repaid from plant revenues.

Alabama approved the laws at the close of the legislative session in November. Kentucky's law was passed in January, but remained inactive until approved by the State Court of Appeals, Oct. 21. R. F. C. loans in Kentucky for water works projects already include Columbia, $29,000; Maysville, $47,000 and Covington, $75,000. $305,000 was granted to Hopkinsville for sewers and disposal plant. Bowling Green takes bids Dec. 19 for first sewer contracts, under a $616,000 R. F. C. loan.

Eleven states now have these laws and many of the 41 state legislatures meeting in January will consider them to relieve general property taxes and assist cities in securing R. F. C. loans.—*Concrete News,* December, 1932.

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Water Rates Held Not Confiscatory

In a decision handed down on Jan. 12 by Federal Judge Evan A. Evans of the Circuit Court of Appeals and Judges James H. Wilkerson and Walter C. Lindley of the District Court of Illinois, it was held that rates prescribed by the Illinois commerce commission for the Kankakee Water Co., which would yield a probable return of 5.17 per cent on investment, were not confiscatory. The decision denied the Kankakee company the right to charge a rate higher than that set by the commerce commission.

THE SAN ANTONIO SEWAGE TREATMENT PLANT

By W. S. STANLEY

Chief Chemist and Superintendent

THE city of San Antonio, Tex., until 1930 disposed of its sewage by discharging it untreated into Mitchel Lake, a body of water, comprising 876.91 acres. This was done under a contract with the San Antonio Irrigation Co. which used the sewage for irrigating land for raising cattle feed. As the population increased, the flow of sewage became greater than the irrigating needs for the land reserved for that purpose, and Mitchel Lake was gradually becoming polluted to a dangerous degree.

In 1928 plans were completed for a sewage treatment plant and the work begun in 1929. In October 1930 the plant was finished and put into operation.

The San Antonio sewage treatment plant is of the activated sludge type employing separate sludge digestion. The designed capacity is for 30 m.g.d. or an equivalent of 400,000 population. The present sewage flow averages 19 m.g.d.

The sewage enters the plant through a 72-in. concrete sewer and into a 60-in. x 36-in. venturi meter tube, connected to a meter which automatically indicates and records the flow. From the venturi chamber the sewage passes into the screen house. The screen house contains one Dorrco automatically cleaned bar screen ½-in. opening, one manually cleaned ½-in. bar screen, an incinerator for burning the screenings and the Venturi meter recorder for raw sewage.

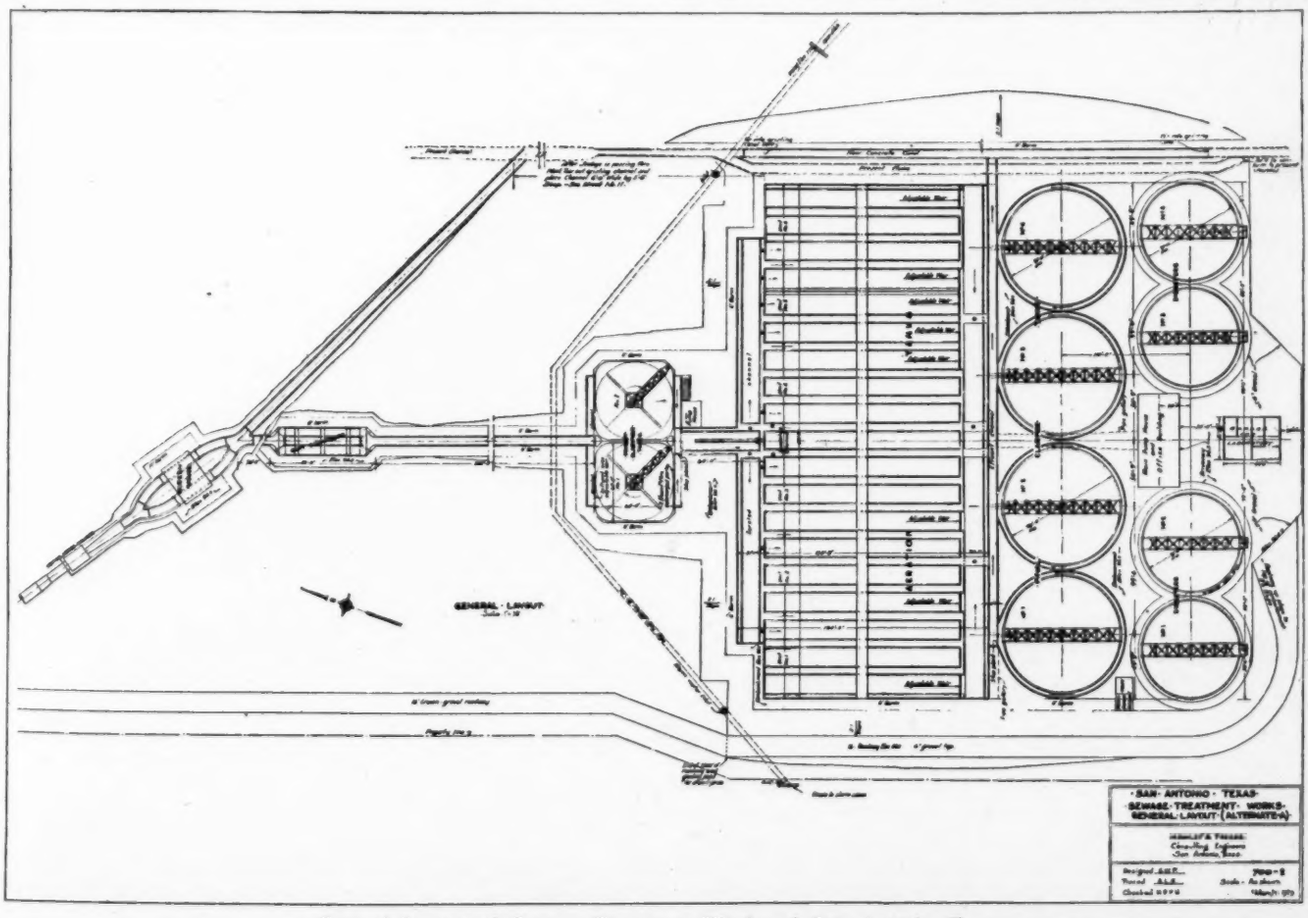
The sewage next enters the grit chamber consisting of three channels thus reducing the velocity of sewage flow 48 per cent, when two channels are in operation. From the grit chambers the sewage flows into distributing channels equipped with filtros plates for short period aeration. This demulsifies much of the oil and grease contained in sewage and brings them to the surface.

Primary Settling and Aeration Tanks

Following this short period aeration the sewage enters two preliminary sedimentation tanks, 60 ft. square by 10 ft. deep. The tanks are equipped with Dorr traction thickeners and skimming arms. The settled sludge is removed through central discharge pipes by two Dorrco triple diaphragm pumps and conveyed into digestion tanks.

From the primary settling tanks sewage enters the aerated mixing chamber, where it meets a stream of activated sludge. This chamber is of spiral flow type and has two outlets for the mixed liquor.

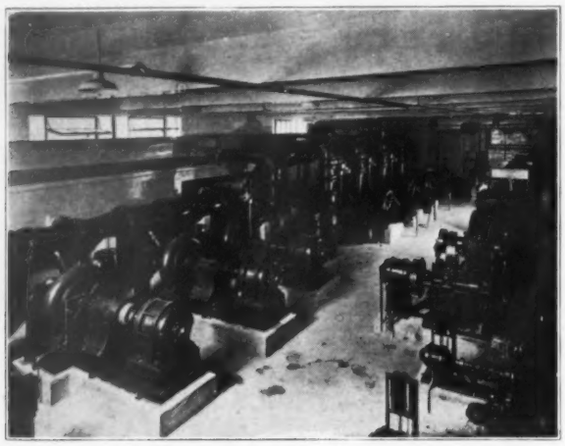
From this tank the mixed liquor, now split in two equal parts, enters the north distributing channels and thence it is further divided among six aerating tanks,



General Layout of Sewage Treatment Works of San Antonio, Tex.

placed in batteries of three on the east and west sides of a central tank, located opposite the mixing chamber and running north and south. The central tank is used for reaeratinon of the returned sludge.

All aerating units are designed on the spiral flow principle, and consist of three channels, each 20 ft. wide



Basement at Power House. "G. E." Blowers in Right Rear; Pumps in Foreground.

by 15 ft. deep and 150 ft. long. The sewage travels in the channels as follows: First in the southerly direction, then back towards the north, then south again and into the south distributing channel, so that the total travel of mixed liquor amounts to 450 ft. In one of the aerating units the upper portion of a wall separating the aerating channels has been omitted for experimental purposes, thus forming one channel of 40 ft. in width.

Final Settling Tanks

From the aeration tanks the mixed liquor enters through submerged 42-in. pipe into the centers of four final settling tanks, 90 ft. in diameter and 15 ft. deep. The 42-in. pipes terminate in upturned elbows, through which the aeration tank discharge spills into an octagonal baffled space. The baffles prevent radial currents from forming across the surface of the settling tanks. The overflow of the settling tanks is peripheral. Total lineal feet of weirs on each tank amount to 238 ft. The weirs discharge the clarified effluent into collecting troughs and into the canal leading to Mitchel Lake.

The final clarifiers are equipped with Butchart thickening mechanism, which sweeps the settled activated sludge towards the center of the tanks. From there by means of centrifugal pumps, the sludge is conveyed into the reaeration channel and thence into the mixing chamber, where it meets settled sewage from the primary clarifiers.

The excess sludge is withdrawn by means of Yeoman's centrifugal pumps and is delivered to separate digestion tanks.

Digestors

The digestion tanks, four in number, 75 ft. in diameter and 24 ft. deep are equipped with Dorr concentrators and scum breakers, also with gas collecting domes and hot water circulating coils. The digester supernatant enters a sump, from which point it is relifted into raw sewage ahead of the primary clarifiers.

The digested sludge is dried upon underdrained sand and gravel beds, 42 in number, each 20 ft. by 100 ft. The beds are built on clay soil. Rows of 4-in. vitrified tile drain, placed loosely in center of each bed connect with a 6-in. lateral. Each bed consists of a 4-in. layer of coarse gravel, followed by 4-in. of ¾-in. gravel and 4-in. of washed sand. The sludge is delivered to drying beds by means of a plunger pump and distributed through a system of pipes and troughs to individual units. A tool house and garage adjoins the sludge drying beds. It also houses the motor for a small experimental grinder of the hammer mill type.

Blower House and Pumping Station

The blower house is a 1-story structure with basement and operating gallery. A General Electric Co. pannel switchboard, a Mid-West air filter and a work shop occupy the ground floor. The basement houses the following:

1. Four "G. E." centrifugal compressors, each of a capacity of 9,000 cu. ft. of air per minute at 8.5 lbs. pressure per square inch and driven by "G. E." synchronous 440 horse power motors.
2. One 8-in. Dayton Dowd centrifugal drain pump driven by "G. E." induction 30 horse power motor.
3. Three 10-in. by 8-in. Yeoman's centrifugal sludge return pumps, each driven by "G. E." induction 10 horse power motor.
4. Two 4-in. by 3-in. Yeoman's centrifugal excess sludge pumps, each driven by 2 horse power motors.
5. One 7-in. by 10-in. Worthington Triplex digester sludge pump, driven by a 15 horse power motor.
6. Two Bryant water heaters, with hot water circulating pumps.
7. Two Connersville gas meters.

The following venturi meters, manufactured by the Builders Iron Foundry are located in the basement of the blower house:

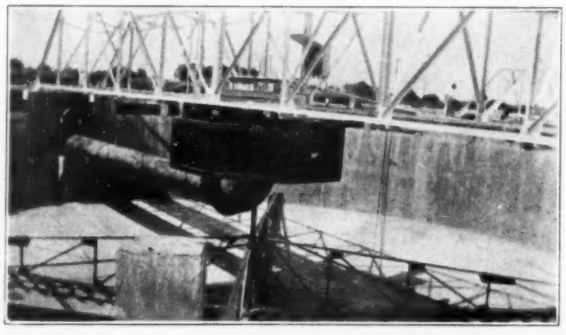
One excess sludge meter.
One return sludge meter.
One air meter.

The operating gallery is ventilated by two American Blower Corp. Siroco fans.

The digester supernatant sump is emptied by a 500 g.p.m. Yeoman's sewage pump, controlled by means of a mercoid pressure switch and driven by a "G. E." 10 horse power motor.

A fully equipped chemical laboratory occupies a building which also contains the office, dressing rooms and a three car garage. A separate garage shed for seven cars is also provided.

Oil, grease, gasoline and kerosene are kept in an oil house built at a safe distance from the remaining structures.

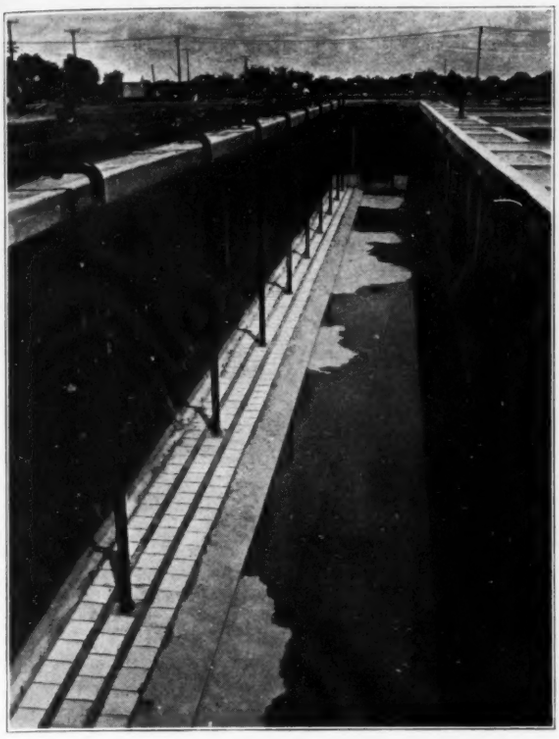


Final Clarifier of San Antonio Sewage Treatment Plant.

The plant was designed by Hawley & Freese, Consulting Engineers, Fort Worth, Tex.

Since acceptance of this plant by the city, the following units were added:

1. Digester supernatant sump and pump.
2. Sludge drying beds were built to replace lagoons, originally included in the project.



Northwest Distributing Channel at San Antonio Sewage Treatment Plant.

Cost of Construction

The sewage treatment plant was built for a capacity of 30 m.g.d. or an equivalent of 400,000 population.

The construction cost may be divided as follows:

Chief Chemist and Superintendent.

General contract	$654,000.00
Water mains	13,321.00
Machinery	39,698.00
Clarifiers	23,900.00
Screens and pumps	85,705.00
Engineering and inspection	53,500.00
Land and right of way	26,365.00
Fences	700.00
Extras	400.00
City labor preparatory to operation	3,853.79
Total initial cost	$901,442.79
Items added by the city after the plant was accepted:	
Supernatant overflow sump and pump	$ 5,000.00
Sludge drying beds (84,000 sq. ft.)	32,885.96
Total	$ 37,885.96
Grand total of construction to date	$939,328.75

Cost of Operation

The initial operating expense from October 15, 1930, to the end of the fiscal year ending May 31, 1931, was rather high due to inexperienced personnel, troubles arising from adjustments to equipment and other causes incidental to a new project.

The cost per capita connected population, based upon the budget for the fiscal year 1931-1932, was as follows:

Interest on bonds	$39,600.00
Depreciation	20,000.00
Budget	79,500.00
Total	$139,100.00
Population of San Antonio	231,542
Less number not connected	50,000
Population using sewage plant	181,542

Cost per capita per year, 76 cents.

The budget for 1931-1932 was expended for operation and extra work, such as widening of the effluent canal, survey of Mitchel Lake, elimination of infiltration and construction of sludge drying beds.

By referring to Table I it will be noted, that the expenses for the fiscal year ending May 31, 1932, were divided as follows: Labor 50 per cent, power 45 per cent, supplies 5 per cent.

The average cost per million gallons of sewage treated was for that year $10.57. This figure is for operation alone, no allowance being made for depreciation, retirement of bonds nor interest.

TABLE I—OPERATING EXPENSES OF SEWAGE TREATMENT PLANT OF SAN ANTONIO FOR FISCAL YEAR ENDING MAY 31, 1932

Month	Labor	Power	Supplies	Total	Cost per M.G.S.
June	$3,050.00	$3,076.50	$372.17	$6,498.67	$12.00
July	3,003.76	2,631.00	528.40	6,163.16	9.75
August	3,010.20	2,644.00	654.22	6,308.42	10.30
September	3,020.00	2,866.55	170.76	6,057.31	11.84
October	2,970.00	2,721.60	344.61	6,036.21	11.50
November	2,908.80	2,415.00	262.87	5,586.67	11.50
December	2,880.00	2,429.35	348.46	5,657.81	11.72
January	2,717.50	2,578.10	269.11	5,564.71	11.00
February	2,525.00	2,660.00	65.43	5,250.43	11.18
March	2,468.30	2,566.90	194.32	5,229.52	9.80
April	2,525.00	1,798.30*	183.69	4,506.99	8.05
May	2,525.00	1,683.50*	103.80	4,312.30	8.20
Totals	$33,603.56	$30,070.80	$3,497.84	$67,172.20	†$10.57

*Power rate now available is 7 milles per K.W.H. †Average.

It is interesting to note the effect of the retrenchment program, so general over the country, upon the operating expenses of this plant: In May 1932, as compared with June 1931, the reduction in cost was 34 per cent. This reduction in cost of operation was made possible by bringing down the air consumption to an absolute minimum, and by curtailing such desirable but non-essential activities as beautification of the grounds. Another substantial reduction was due to the obtaining of a lower power rate of 7 mills per kilowatt hour.

General View from Roof of Power House Looking North. Final Clarifiers in Immediate Foreground.

The Sewage Treatment Plant comes under the jurisdiction of the Department of Streets and Public Improvements, of which Paul E. Steffler is Commissioner.

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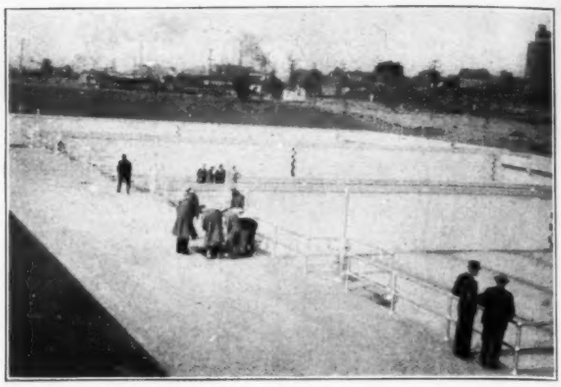
First Steam Pumping Plant—The first use of the steam engine for pumping was in Philadelphia in 1800. The first public water system in the United States was built in Boston in 1652.



New Storm Water Stand-By Tanks on Columbus Intercepting Sewer.

OHIO CONFERENCE ON SEWAGE TREATMENT

THROUGH the courtesy of H. E. Schlenz of the Pacific Flush Tank Co. we are able to present in brief some of the outstanding papers read before the Sixth Ohio Conference on Sewage Treatment which was held recently at Columbus, O.

An important matter under consideration by the Conference is that of licensing sewage works operators. The committee which reported on this subject made the recommendation that more study be given it, with the idea of obtaining a State Act, similar to that already in existence in New Jersey, which requires all sewage plant operators to qualify as "Licensed Sewage Works Operators" before assuming responsible charge of sewage works operation. Operators are required to successfully pass an examination given by the Engineering Division of the State Department of Health, whereupon they are licensed as first, second or third class operators. A plant giving "complete" treatment to sewage is classified as a first-class plant, and it is stipulated that only operators possessing a "First-Class Operators License" can be employed to assume charge of such a plant by a corporation, a municipality or other political subdivision within the state.

G. E. Flower, Superintendent Southerly Sewage Works, Cleveland, O. Retiring Chairman of the Conference.

New Officers:

The following officers were elected for the ensuing year:

Chairman—T. C. Schaetzle, Superintendent of Sewage Treatment, Akron, O.

Vice Chairman—W. B. Lockhart, Superintendent of Sewage Treatment, Fostoria, O.

Secretary-Treasurer—J. R. Collier, Superintendent of Sewage Treatment, Elyria, O.

Editors—F. D. Stewart and B. M. McDill, Engineers of the Ohio State Department of Health, Columbus, O.

Papers and Discussions

"Hazards Due to Gases at Sewage Treatment Works," by **Dr. R. R. Sayers,** Chief Surgeon of the U. S. Bureau of Mines and the U. S. Public Health Service.

Dr. Sayers pointed out the three hazards existing as result of gases met with in sewage treatment practice. The first embraced dangers of explosion and fire from mixtures of air and gasoline vapors, carbon monoxide in water gas or methane; the second was that of suffocation (dilution of the oxygen content of air) due to presence of non-life sustaining carbon dioxide or methane; the third danger was that of poisoning such as occurred when hydrogen sulphide was breathed in too great concentrations or for too long a period. A mixture of air and methane containing between 4.5 and 14 per cent methane would be explosive. Air containing 2.4 per cent or more gasoline vapor was explosive. An atmosphere containing more than 8.5 per cent of carbon dioxide (CO_2) was to be considered dangerous because of the lowered oxygen content. The same remark, he said, applied to methane. P three. Hydrogen sulphide (H_2S) was distinctly toxic—0.01 to .05 per cent (100 to 500 parts per million) being considered as the range above which distinct danger existed.

Good ventilation of sewers, tanks and pits was of paramount importance to safeguard lives of workers. Gas masks of the "all service" type were useful for absorbing toxic gases but was of no avail in atmospheres too low in life sustaining oxygen. The use of a mask with a breathing hose having an outside intake and the stationing of a fellow worker to give assistance when necessary were important suggestions made by Dr. Sayers. Ropes should be tied to workers performing hazardous duties.

T. C. Schatzle, Chemist in Charge Sewage Treatment Plants, Akron, O. Chairman-elect of the Conference.

Dr. E. R. Hayhurst in discussion stressed the importance of exercise of care and coolness on the part of the rescuer of a person in a gas laden chamber. The rescuer because of exertion and rapid respiration would be more quickly overcome and be less subject to later resuscitation than the original victim. It had been a fact that would-be rescuers had died whereas the rescued victim had recovered.

"The Influence of the Discharge of Sewage on Minute Forms of Stream Life," by **W. C. Purdy,** Special Expert of the U. S. Public Health Service.

Mr. Purdy placed a typical stream under the microscope for the conference, so to speak, and traced the pollution in an average stream until, by the processes operating in self-purification, it had again recovered its natural equilibrium. It was felt from

studies made by the Public Health Service that bacterial forms were the first to break down organic matter. When sedimentation takes place in the lower reaches of pollution, bottom sediments are easily overcome. An interesting organism, playing an important part in converting organic bottom deposits to mineral matters and simpler organic matters, was the sludge worm. Its ability to work over deposits is unsurpassed, one worm being able to pass fecal pellets from its body each 24 hours that exceeded 65 times its own length. Such action brings sludge from the bottom to the surface, where it can be more readily attacked by forces of purification.

In answering a question regarding the bulking of activated sludge at sewage treatment plants, Mr. Purdy stated that at the laboratory in Cincinnati an attempt was to be made to study this matter. He stated that from past experiences it is evident that bulking appears simultaneously with the presence of foreign growths. An instance of sludge bulking at Tenafly, N. J., was cited where the growth occurring was many times the normal volume of the activated sludge.

"The Value of Nitrogen Determinations in the Operation of Sewage Treatment Plants," by **F. W. Jones,** Chemist in Charge of Sewage Treatment Plants, Cleveland, O.

Mr. Jones, in a highly interesting paper, stated that it was principally the nitrogenous compounds in sewage which were responsible for its offensiveness. He stated that practically all of the nitrogen in domestic sewages may be accounted for in the urea and is therefore primarily in the soluble form. The albuminoid nitrogen test, so frequently omitted by plant operators because of burdensome procedure of determination, should not be considered unimportant in sewage analyses.

George B. Gascoigne, Consulting Engineer, of Cleveland, O., brought up the question of what really happens to the ammonia in sewage during the treatment process? Was it acted upon bacterially, chemically or mechanically? The answer was that it appeared to be broken down by bacterial action alone.

"Present Trends in Sludge Disposal," by **R. A. Allton,** Engineer of Sewage Disposal, Columbus, O.

Robt. A. Allton, Engineer Sewage Disposal, Columbus, O.

Mr. Allton reported on the experimental work being conducted at the Columbus plant on vacuum filtration of sludges. To date digested sludge from the Imhoff tanks had been conditioned with lime and ferric chloride before filtration. Further studies will include filtration of raw solids directly. It has been shown that the filtration of mixtures of activated sludge and raw solids is practicable. The experimental work had shown the need of some sludge storage to provide a "take up" in the process. To take care of a peak day it would otherwise require provision of five times the normal filter and dryer capacity needed for the average production. It seemed feasible to utilize such a sludge storage tank as a small capacity digestor to aid in conditioning before filtration, but he felt that a more complete digestion should be carried out on the sludge to be stored because of the overall benefits to be derived.

In answering a question about the chemicals used in conditioning, Mr. Allton stated that the greatest success on Imhoff sludge seemed to be had with ferric chloride and lime. At Columbus an alkaline sludge is encountered and lime had been used successfully, whereas acid with the iron salt did not give desired results. When the volatile solids were low, say below 50 per cent (dry), it was possible to obtain sufficiently high rates of filtration with ferric chloride alone.

Asked, if this did not indicate that it might be most feasible to digest the sludge before filtration, Mr. Allton replied that such was a problem of economic importance and is now in the process of being studied.

Replying to the question, as to what effect does heating have on filtration, Mr. Allton said that heating to 60 degrees F. seemed to aid in obtaining better filtration rates and at 80 to 90 degrees F. even better results were had.

R. T. Regester, Engineer of Sewer Design, Columbus, O. (He knows his manholes.)

In answering a question, concerning the effect of varying moisture content of sludges upon filtration, Mr. Allton stated that it had not appeared to be a matter of much consequence, but that a sludge carrying 5 to 7 per cent solids seemed to give the best results.

In answering a barrage of questions directed to him, Mr. Allton brought out the following points: The filtrate from the filter is run back into the raw sewage with apparently no adverse results. Ferric chloride is used to the extent of about 4 lbs., of $FECl_3$ to 100 lbs. of solids as determined on the dry basis. The yield of the filter, handling digested sludge, had been about 6 lbs. of dry solids per sq. ft. per hour. About one-half of the total cost of filtration was represented in the cost of chemicals.

F. E. Kurz, Engineer of the Oliver Filter Co., recounted some of the findings during large scale filtration and incineration tests undertaken by the Chicago Sanitary District. The filtration had been carried out using mixed solids containing 50 per cent raw solids and 50 per cent activated sludge solids, the mixture having a 94 to 95 per cent moisture content. In the drying process care had to be used to prevent scorching or burning in the dryer if odors were to be prevented. In both the drying process and incineration of the dried sludge the control of odors became a matter of maintaining proper temperatures.

M. W. Tatlock, Superintendent Sewage Treatment at Dayton, O., stated that at Dayton a temperature of 1,500 to 1,800 F. was necessary to insure odorless incineration of screenings. If the temperature drops to 1,200 F. odors are produced and if scorching takes place the odor is very bad.

"The Determination of pH Value of Sludge," by **J. R. Collier,** Superintendent of Sewage Treatment Works, Elyria, O.

The meaning of pH values was depicted in a very understandable manner by Mr. Collier. He brought

out the fact that temperature exerts a marked effect upon pH readings. It was common practice to use diluted filtrate of the sludge sample for the determination, but the most dependable results appeared to be obtained by testing the supernatant liquid after centrifuging the sludge sample. Having stated that it was impossible to associate pH with definite conditions at all plants, or even at times at the same plant, Mr. Collier cited a case wherein the pH of sludge remained the same even though the total alkalinity was greatly changed. A tank had been foaming and upon liming the sludge alkalinity changed but the pH was not affected. Foaming was stopped, nevertheless.

Mr. Dakin, Assistant Chemist at the Sewage Treatment Works, Dayton, O., stated that it appears that the solids in sewage have a pH value differing from the liquid portion. That, he thought, might account for the higher values (0.3 to 0.4 pH value) generally obtained when the determination was made on a filtered sample. When setting sludge aside in order to obtain a supernatant liquor sample, the pH value frequently changes during the holding period.

"B. O. D. Determinations," by **R. D. Scott,** Chemist of the Ohio State Department of Health.

Mr. Scott stated that a procedure using a synthetic diluting water which was found to give the most consistent results in the work of the Lake Erie and the Ohio River Boards was described. This method is to be adopted as standard by the Ohio State Board of Health and indications are that it will be included in the new edition of "Standard Methods" of the American Public Health Association.

F. W. Jones said that in his experience regardless of the fact that the same identical procedure, diluting water and solutions are used by ten persons at the same setting there would be ten different results secured from the B. O. D. determination, and **F. G. Browne** of Marion, O., agreed as to the importance of the personal element which had become very evident during his experience with the use of stored water vs. synthetic water in the B. O. D. test.

"Experience with Paint About Sewage Treatment Plants," by **F. G. Browne,** Superintendent of Sewage Treatment, Marion, O.

Mr. Browne's contribution was of practical value to operators in attendance. He contended that the value of paint is dependent upon its physical as well as its chemical properties. He stated, that due to the fact that conditions imposed upon structures about a sewage treatment plant are exceedingly severe, it was imperative that protection be given to mechanisms and concrete *at once* before corrosion or disintegration starts.

In closing he stated that it was his opinion that the most practical solution to the problem might well be found through the extended use of non-corrosive materials in sewage works construction.

Columbus Works Inspected

An inspection trip was made to portions of the extensive new intercepting sewer system of Columbus. The large regulating chamber, and the storm-flow standby tanks were visited, as was the experimental station at which sludge conditioning and dewatering tests were under way. The plan of operation of the storm flow tanks constitutes a novel scheme of flow regulation in American practice.

Second Annual Water Works School To Be Held by Rutgers University

Rutgers University announces a short course for Filter Plant Operators and Water Works Superintendents to be held at the University in New Brunswick, N. J., February 6 to 18, 1933, under the direction of the College of Engineering and in cooperation with the South Jersey Association of Water Superintendents and the New Jersey State Board of Health.

The course of study has been planned to provide instruction in the fundamental principles of water works management and maintenance filter plant operation. The quality of water, development of the sources of public water supplies, design and operation of distribution systems and filtration plants will be covered by lectures and recitations. A laboratory course will be given covering the details of filter plant operation and in which the student will make actual tests and analyses.

The two weeks' period of instruction offers an opportunity to those wishing to become operators and water works superintendents, to qualify themselves to meet the requirements of the New Jersey State Department of Health. It is also an opportunity whereby water works officials and employees may increase their knowledge of public water supply and water treatment and to better qualify themselves to solve their individual problems.

Instruction in the course will be given by members of the University faculty. Professor H. N. Lendall will have general supervision of the school and will conduct the recitations and lectures and Dr. William Rudolfs, assisted by his staff, will have charge of the laboratory work.

Definite periods will be assigned for informal discussion of various problems in water works operation and management. The discussions will be led by men of experience and authority in the water works field. Two days will be devoted to visiting nearby water plants.

The total expense for the entire two weeks' course will be approximately $15.00 for Non-Resident Students. For Resident Students, $30.00 in addition will cover room and meals.

Requests for further information should be addressed to Professor H. N. Lendall, Engineering Building, Rutgers University, New Brunswick, N. J.

NOTE: Any person may attend the Short School. There are no educational requirements for admission —Editor.

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Ray F. Goudey and W. W. Hulbert Honored by California Section, A. W. W. A.

Raymond Freeman Goudey, sanitary engineer of the Bureau of Water Works and Supply, was elected president of the California Section, American Water Works Association at its annual convention in San Diego, Oct. 24 to 28.

William Whitehead Hurlburt, Engineer of Water Works of the Los Angeles Water Bureau and Past President California Section, was named Regional Director of the American Water Works Association. He will take office after the Chicago convention next year, succeeding S. B. Morris, chief of the Pasadena Water System.

The meeting in San Diego was highly successful. More than 400 water works men were in attendance.

FILTRATION PLANTS

A Section Dealing with Their Design, Construction and Operation

Conducted by JOHN R. BAYLIS, Associate Editor

Physical Chemist, Bureau of Engineering, Chicago, Ill.

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THE FUTURE OF WATER TREATMENT AND FILTRATION

PERHAPS it is unwise to attempt to predict the future of a practice that has been developing so rapidly as has the treatment and filtration of water, yet there probably are many who are now in more or less of a quandary as to what to do and would welcome a prediction as to what the future might bring forth. Some may feel that future developments in water treatment will bring about radical changes which are not now anticipated, tending to make obsolete many plants or certain parts of plants now in operation. Changes, no doubt, will be made in the future, but probably no extensive reconstruction will be necessary.

Recently the writer was talking with an engineer who had just finished designing a plant. He stated that he had provided for practically everything he could think of in the design, knowing that there would be some idle equipment regardless of the manner in which the plant was operated. Lacking in knowledge concerning all of the characteristics of the water and the direction in which water treatment may swing in the future, this was a very sensible design. Should a different treatment from that now contemplated later be found best, the modest extra expenditure for the present plant equipment will likely avoid expensive or decreased efficiency in operation.

The purpose of this article is to set forth what appears to be the ultimate aim of those who are operating water treatment plants. The statements will apply to average conditions and not to specific plants.

Coagulants and Feeding Devices

Coagulants.—There is no reason to expect material changes in the types of coagulants now in extensive use. Practically all coagulants used in water treatment produce a precipitate of aluminum or ferric hydroxide. There will be an increasing use of iron compounds for coagulating water. The present low price of chlorine may make feasable the manufacture or home production of ferric chloride at a cost at which it can compete with aluminum sulfate. It is believed, however, that aluminum sulfate will continue to be the most extensively used coagulant in water treatment where the problem is primarily one of clarifying the water. In connection with municipal water softening there is some doubt as to what the future will bring forth in the coagulant used. All of the iron salts give very satisfactory results when the pH is high, but aluminum sulfate is also giving satisfactory results in a number of softening plants. There may be no material change in the coagulants which will be used in connection with softening in the future.

Chemical Feeding Devices.—Most filtration plants constructed within the past few years have been equipped with dry feeding machines for handling such chamicals as are purchased in the powdered or granular form. There are a variety of chemical feeding devices on the market, with decidedly the majority of such devices measuring the chemicals by volume. These machines give very accurate proportioning of the chemicals so that the amount fed into the water is uniform in proportion to the water treated.

It does not seem probable that dry feeding methods will be replaced in filtration plants. There may be new machines developed, but measurement of the chemicals in the dry state in controlling their application to the water has come to stay. It will be under unusual conditions or at small plants where solution feed will be more suitable than dry feed.

Within the course of time it probably will become customary to set or suspend the dry feed machines on scales, as is now the case in a few installations. This will add little to the cost and will insure more uniform application of the chemicals to the water. The present method of keeping track of the amount actually added to the water where the machine is not mounted on scales is to keep an account of the amount added to the machine. This is not as satisfactory as having an accurate weight of the amount used every hour or during intervals shorter than 24 hours.

Mixing Chambers and Settling Basins

Mixing Basins.—The time of mixing in existing plants varies all the way from just enough mixing to get the chemicals uniformly distributed throughout the water to more than 60 minutes in a few plants. Perhaps an average mixing time for water treated with aluminum sulfate is about 20 minutes. There are two distinct types of mixing basins—one in which the water flows by gravity through baffled basins, and the other in which the momentum imparted to the water is had through the use of mechanical devices. The gravity flow mixing basin may be just a long conduit, a series of horizontal conduits, a series of vertical conduits, or circular basins with spiral inward flow. The mechanical basin makes use of some form of power driven paddles to create the desired speed and character of mixing.

The flexibility of mechanical mixing will insure its

being used extensively in plants constructed in the future. Most any type of basin or device which imparts the desired gentle agitation to the water will be suitable. It is not likely that many plants will convert their present baffled basins into mechanical basins, unless there is some reason for reconstructing the basin. Long periods of mixing will be provided for most of the plants constructed in the future, and the average time of mixing for plants employing a simple coagulant probably will be slightly in excess of 30 minutes. There may be an increase in the number of mixing basins which will make it possible to produce somewhat violent agitation at the beginning of the mixing process followed by a gradual moderation toward the outlet end.

Where the water is not very turbid the momentum imparted to the water should be less than for very turbid waters. It probably should not be much in excess of 0.5 foot per second for the last half of the mixing period. Such a low velocity with very turbid water probably would allow the mixing basin to partially fill up with sediment.

It is not believed that extremely rapid mixing devices for the initial mixing of the chemicals with the water will come into general use. The cost of the power to produce violent agitation is not justified for the very little increased efficiency resulting from such mixing. Where pumping is done the pump impellers will serve the purpose without added power expense.

Entrance to Settling Basins.—In a number of filtration plants excellent flocculation of the coagulated matter is produced in the mixing basin, only to be broken up to such an extent by the time it reaches the settling basins that much of the value of the mixing basin is lost. Sometimes this is due to the outlet of the mixing basin being too small, the flow in the channel from the mixing basin to the settling basins being too rapid, or the entrance to the settling basins is of a design which creates a break up of the flocculated particles to a material extent. Such, for example, will occur when there is a rapid flow through slots or a drop over an entrance baffle.

Sufficient study has not been given to this feature in the design of water treatment plants. When fairly short periods of mixing are used and the flocculated particles have not built up very large, this is not of importance; but where there is a long period of mixing which has produced large flocculated particles the outlet from the mixing basin and inlet to the settling basins should be such that the velocity imparted to the water is not increased materially above that in the mixing basin.* It may not be possible, without considerable expense, to correct conditions in existing plants where there is trouble from the floc being broken up, but future designs should be such that there will be no such trouble.

Coagulation-Settling Basins.—There is no reason to believe that there will be material changes in the design of settling basins in the future, except there will be an increase in the number which use mechanical sludge-removing devices and other mechanical equipment. In some of the plants where there is inadequate mixing in the part of the plant provided for the mixing there will be conversion of part of the settling basins to provide added mixing facilities to the plant. Some plants may construct the usual types of baffled basins but most of them will use mechanical devices.

*In this respect one might cite the case of the Richmond, Va., filter plant where rapid mixing is secured in the original baffled mixing chamber. The flocculating effect is produced by slowly rotating paddles across the inlet end and inside of the existing coagulating basins. Thus the author's ideas have already been put into effect and produce results contemplated.—EDITOR.

Mechanical "flocculators" installed at the inlet ends of settling basins will be worth many times their cost in a number of plants. Such flocculators suggest the probability of having mixing basins just sufficient in size to insure rapid and uniform mixing of the chemicals with the water and to just start the formation of the floc, then the water will be passed to the large basins provided with mechanical flocculators installed at the entrance ends. The balance of the basin will then serve as settling basin. The flocculators probably should occupy about one-fourth of the basin where the total capacity of the basins is about 4 hours flow of water. When this type of mixing is used to produce large flocculated particles there is no danger of the particles being broken up as they pass to the section of the basin provided for sedimentation. It seems probable that a number of plants will install flocculators in their settling basins in the future.

Filters and Appurtenances

Filters.—A very lengthy article might be written about probable future developments in the design and operation of filters, yet no one can predict with much certainty what will take place in the design of filters in the future. Some are so bold as to predict that there will be many changes. With improvements in conditioning the water so that the filters may handle the little suspended matter remaining in the water after sedimentation without difficulty, some may feel that it is not necessary to watch the performance of the filters as closely as has been thought necessary in the past. There is an increasing demand for more perfectly filtered water, and consequently it will be necessary to keep the filter beds functioning in a highly efficient manner.

In regard to the shape and general arrangement of the filters, it is not believed there will be many changes. Rectangular tanks 8 to 12 feet deep, with an underdrainage system overlaid with 12 to 18 inches graded gravel, and a bed of sand 24 to 30 inches in depth, will continue to constitute the design of most of the filters. Due to air-binding troubles, filters probably will be constructed to carry a greater depth of water above the sand surface than has been the usual practice heretofore. The beds should be low enough so that practically no negative head will be developed in the sand bed when the loss of head is at the maximum. This adds little to the cost and insures less trouble from air-binding.

Filter Underdrains.—The design of filter bottoms has not entirely passed out of the patented appliance stage, and the type of bottom selected is frequently influenced considerably by efforts on the part of those controlling patents. It is believed that a system of lateral piping with perforations will be used most extensively in the future. Just what form the perforations will take is difficult to predict. It is not believed that strainers will be used to any material extent in future designs.

The underdrainage system should be considered in the light of a device to more evenly distribute the wash water over the filters than as one to collect the filtered water uniformly over the bottom. The even collection of the filtered water is of minor consequence compared with the necessity of an even distribution of the wash water. The hydraulics of underdrainage systems is not as well understood as it should be, but in the course of time there will be information available to enable one to compute very accurately the size and number of openings in the underdrain laterals to insure uniform distribution of the wash water. The recent tendency to use higher rates in washing makes this of still greater

importance. It is believed that future developments in the underdrainage systems will be along the line of varying the size and number of openings in pipe laterals to insure even distribution of the wash water, and that none of the patented types of bottoms will come into extensive use.

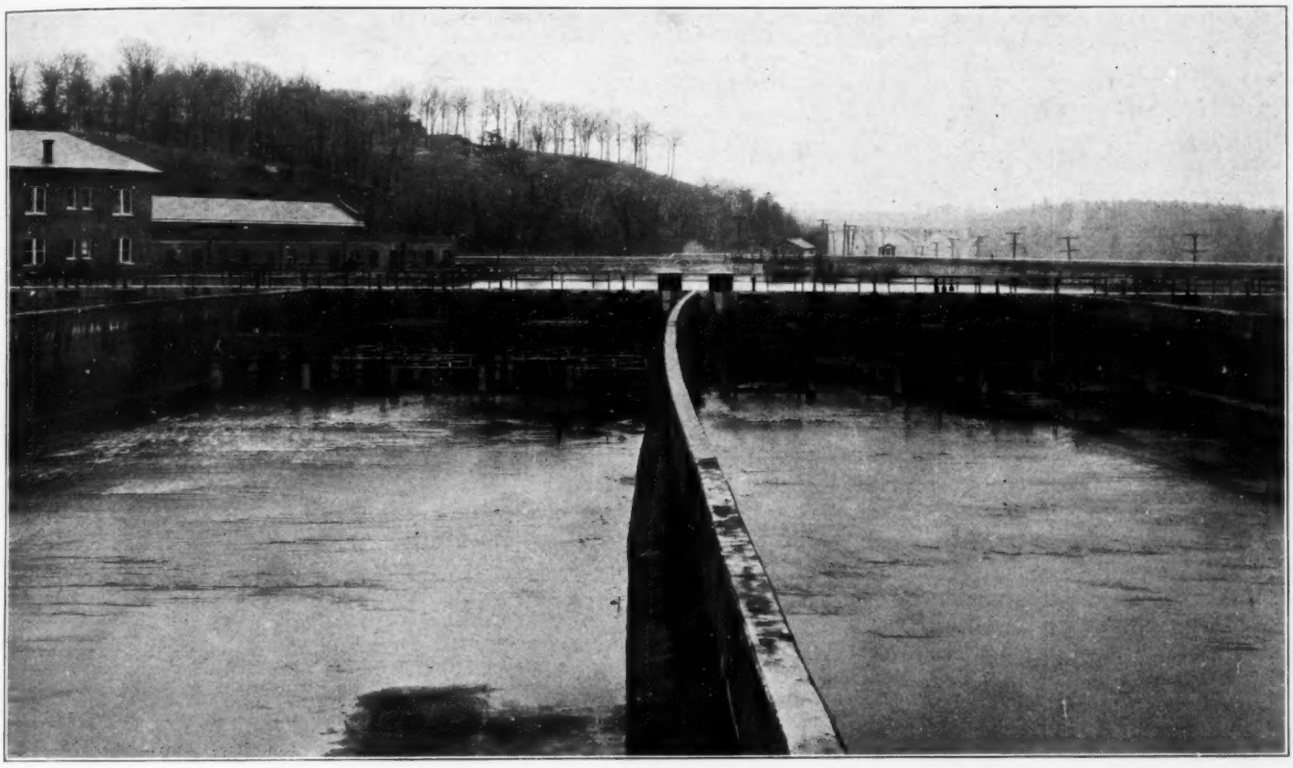
Filter Rate Controllers.—Filter rate controllers actuated with a venturi tube will continue to be the most extensively used device for measuring and controlling the flow of water through filter beds. If changes are made in present types of rate controllers these will probably be largely in the mechanism for automatic control of the flow, and in the recording and indicating devices which measure the rate of flow and loss of head through the filter bed.

The leading manufacturers of filter rate controllers now have their equipment simplified to the point where it does not seem possible to make them much more simple. Recording charts for each filter are not used as extensively as they should be, and it is believed in the course of time that most of the plants will install equipment for the use of such charts for both the rate of flow and the loss of head. There is nothing like a recording chart to tell the past performance of a filter, and all filters should be so equipped.

Sand and Gravel Beds

Sand Beds.—There is not likely to be much change in the depth of the sand beds on the size of the sand grains now extensively used. There has been a tendency to use coarser sand than has been specified in the past and it is likely that most filter beds constructed in the future will have sand between 0.4 and 0.5 mm. dia. for the 10 per cent size, commonly called the effective size. There was once a belief that the sand in a filter bed should be as uniform in size as is possible to obtain. Lately many have formed the opinion that the sand can be too uniform in size. The writer is of the opinion that sand cannot be too uniform in size when there is the proper gradation from gravel to sand in the filter bed; however, it is believed that there is no great advantage in having sand with a uniformity coefficient less than 1.50. A few specifications now give limits for the one or the two per cent size. It is believed that future specifications will limit the one per cent size to about 0.7 to 0.8 of the 10 per cent size, and that preference will be given to sand with the one per cent size still nearer the 10 per cent size.

It has been demonstrated that the shape of the sand grain has little influence upon the results produced by the filter, and it is likely that anything from crushed quartz to perfectly rounded sand will be satisfactory. It is believed that there is no advantage in having sand beds of much greater or lesser depth than about 24 ins.



Flocculators at the Richmond, Va., Filtration Plant; Invented by M. C. Smith, Engineer of Water Supply, Richmond, Va.

Satisfactory results may be obtained with materials other than silica sand, but due to the cheapness and durability of sand it is believed that no other material will come into extensive use.

Gravel Beds.—There is no reason to expect material changes in the gravel beds used for supporting the sand beds in filters. Where pipes are used for underdrains it is customary to use about 18 inches of gravel graded from about 2 ins. in diameter for the largest particles to about ⅛ in. in diameter for the smallest particles. Unless the filter sand contains some fairly coarse material, the gravel should be graded down to about one-sixteenth inch in diameter. Failure to have this intermediate size has given trouble in a few plants. In some instances the sand has found its way through the gravel and has clogged both the gravel and the underdrains. It is believed that more attention will be given to the grading of the materials where the sand joins the gravel. Unless this is done, costly regrading of the materials will be necessary occasionally.

Washing Filters.—This is one part of filter plant design and operation which is likely to be improved quite

materially in the future. Inefficient washing of the sand beds has caused more trouble in filters than anything else. Keeping filter beds in good condition might be termed the main unsolved problem of filtration. Back in the early days of filtration most of the filter tanks were round and were equipped with mechanical rakes which revolved in the sand as it was being washed. The rakes prevented the formation of clogged places and resulted in keeping the beds in better condition than they are now kept in most filters. The use of rectangular tanks has made it impractical to use revolving rakes.

There are various opinions as to the remedy for filter bed troubles. Some feel that if the wash water could be distributed uniformly over the bed that the trouble would be solved, and some believe that if a very high rate of washing is used that this will maintain the beds in good condition. Others believe that inefficient treatment of the water prior to filtration is largely responsible for clogging troubles. A few believe that if fairly coarse sand is used the beds will stay in better condition. It can be shown that all of these items have an influence upon the condition of the sand bed, yet if everything was perfect in regards to sand size, wash water distribution, rate of wash, and treatment of the water prior to filtration, there still would be filter bed trouble, but perhaps to a lesser extent than if the trouble was aggravated by other conditions.

The thing which seems most difficult to get into the minds of the designers and operators of filtration plants is that present methods of washing filters do not produce sufficient agitation in the filter beds to properly remove from the beds the materials which produce clogging. It seems that most every one keeps living in hope that someone will some day discover a certain size sand, a certain type of filter underdrain, a certain rate of applying the wash water, or a modification of the treatment of the water which will solve all filter bed troubles. There will be no such solution to filter clogging troubles, and the sooner we make up our minds to this fact the better, for we can then devote our efforts along lines which offer more hope for the solution of the trouble.

The writer has several times stated that the most probable solution of the problem of keeping filter beds in good condition is to apply jets of water directly into the sand bed while it is being washed. The jets should be sufficient to give violent agitation of the partially suspended sand during the washing periods. There is hardly any limit to the force which may be applied in this manner, and why those engaged in the design and operation of filtration plants do not provide for more effective means of keeping the sand beds in good condition is difficult to understand. The future will eventually bring forth better means of washing filters but it has not come as yet. As to whether it will be in the nature of jets of water from a system of piping slightly above the sand surface, or to some other force, there is no way of predicting at the present time. A solution for filter bed troubles must and will be found.

Chlorination

Chlorination.—We need not expect material changes in the machines used for adding chlorine to water. The manufacturers are constantly striving to simplify their equipment, but from the standpoint of accurately measuring the flow of chlorine gas there is no need for material improvement in the present machines.

Formerly the operators of treatment plants were satisfied to sterilize the water to the extent that it passed the standard for drinking water. To do this required adding chlorine to the extent that the water frequently had a chlorine taste, and the operators were anxious to keep the chlorine application as low as possible. Now that chlorinous tastes can be prevented by the use of ammonia, the tendency is to add more chlorine to insure better bacterial reduction.

In some plants considerably more chlorine than is necessary to sterilize the water is being added to aid in reducing objectionable tastes. Chlorination has now become a part of the treatment process, other than for sterilization, in a number of filtration plants. The strong oxidizing properties of hypochlorous acid may be used to a considerably greater extent in the future for aiding in the treatment processes than has been used in the past. This will depend somewhat upon the extent to which activated carbon is used in the future for absorbing objectionable substances from water. It can be predicted with considerable certainty that the future will bring about more effectively sterilized water.

Water Quality—Taste and Odors

A New Standard for Quality Water Is Needed.—Improvement in controlling chlorinous tastes in water has reached the point where there is no difficulty in producing water practically free from bacteria in nearly all water treatment plants. The standard of the U. S. Treasury Department for common carriers, which allows an average of one B. coli per 100 c.c., is no longer a suitable aim of quality for the water treatment plants. All plants now strive to average much better than the standard. What the water plants need is some definite aim in the bacterial quality of the water. Some may say that the aim should be water entirely free from B. coli. This is more than should be expected, for contamination of the samples after collection will result in an occasional B. coli.

The writer is of the opinion that the standard for drinking water should be an average of not more than two per cent of the 10 c.c. fermentation tubes which show the presence of B. coli, and that the aim of the plant operators should be to produce water in which not more than one per cent of the 10 c.c. tubes show the presence of B. coli. Most of the well operated plants are now averaging better than this lower figure practically all of the time. If the U. S. Treasury Department standard would state what should be the aim in bacterial quality as well as define the limits it would give the operators some figure to which they should strive to meet and probably would result in improving the quality of many waters.

Taste and Odor Removal.—Treatment of water to remove objectionable tastes and odors is being introduced into the water treatment plants so rapidly that the most important statement one may make is that all objectionable tastes and odors will be eliminated from the water of practically all of our public supplies within the near future. Two years ago no one could predict the type of treatment which would be used most extensively, but the trend is now definitely towards the use of ammonia to prevent chlorinous tastes and activated carbon for such tastes and odors as cannot be prevented or removed by use of ammonia. There will be found waters where it is better or cheaper to superchlorinate and dechlorinate the water. Potassium permanganate also may be used in a few plants. There probably will be some extension of the use of ozone in the municipal field. Ozone is proving very successful in a number of small private supplies where a large percentage of the water

is used for drinking purposes or in the preparation of foods and beverages. Many plants will make use of two or more treatments for taste and odor elimination, depending on the cause of the taste or odor and the cost of preventing or removing such.

Prevention of chlorinous tastes by the use of ammonia is an attractive feature of the treatment, but probably the greatest benefit derived from such a treatment is its aid to sterilization. The bactericidal action is slower than when chlorine alone is used, but residual chlorine remains in the water very much longer. This is of particular advantage in insuring good sterilization and in preventing bacterial and algae growths in the distribution system and distribution reservoirs. *Residual chlorine extending throughout the entire distribution will be the practice followed in the future.* This will aid materially in reducing the danger of contamination from cross connections and connections to fixtures which might draw polluted water into the pipes when the pressure is low. Carrying residual chlorine into the dead ends on the distribution system has other advantages including red water reduction.

The use of activated carbon for removing objectionable tastes and odors from water has come to stay. Present indications are that it will be used most extensively in the powdered form. There may be many plants which will install beds of carbon if it is demonstrated that this method of using the material is not much more expensive than the powdered material. Beds of the carbon have the advantage that they are always ready and there is no danger of tastes and odors passing the plant as will occasionally be the case when the powdered material is used in too sparing quantities or is not used to some extent continuously.

Softening

Water Softening.—One might predict considerable development in the field of water softening in the future. It is more a problem of economics than anything else. To be considered, water softening must show a saving to the consumers that will at least nearly equal the cost of softening. The value of clear and palatable water cannot be measured accurately, for no one knows just how much the public will pay for satisfaction. A little of the cost of softening may be charged to satisfaction, but the major portion of the cost must be overcome by a reduction in the cost of using the water by the consumers.

Fortunately a little specific practical information on the saving in soap as a result of softening water is available, and this is decidedly in favor of softening. It is believed there will soon be methods of more accurately estimating the saving resulting from softening, and where the figures show a material saving there should be no great difficulty in creating a local demand for softer water. The amount of softening which a city will undertake will vary considerably. In some cities the economical point will be a hardness of 100 p.p.m. or even more, and in others it may be economical to soften as low as 50 p.p.m. or slightly less. The degree of softening should be carried only to the economical point.

There is no reason to expect material changes from the softening processes used in the plants recently constructed. Now that recarbonation is regarded as an essential part of nearly all municipal softening plants using lime and soda, there will be a tendency to use the excess lime treatment in a number of plants to produce more complete removal of the magnesium. There probably will be an increasing use of zeolites for municipal softening plants, but precipitation with lime and soda alone in conjunction with zeolitic softening will continue to be the most extensively used process. Chemical precipitation should be used for very hard waters even though zeolite may later be used to reduce the hardness to any desired degree beyond that accomplished by precipitation.

Conclusions

Progress in water treatment and filtration gives assurance that the ideal water is almost within the reach of nearly every municipality. It will be water which is sparkling clear, free from bacteria, pleasing to the taste, so free from odors that those with the most sensitive olfactories cannot detect an odor, not very hard, and not corrosive to the distribution and household pipes. This is the kind of water the public desires, the kind for which they are willing to pay a fair price, and the kind they should have and eventually will demand. Let us take steps to produce such a water in every city.

▼

New York State Sewage Works Association to Meet in January

The fifth annual meeting of the New York State Sewage Works Association will be held at the Hotel McAlpin in New York City on January 17th. In the evening a joint dinner will be given with the Sanitary Engineering Division of the American Society of Civil Engineers which holds its annual meeting beginning on the 18th of January.

THE PROGRAM

"Facts and Fancy in Sewerage Financing"—Abel Wolman, Chief Engineer Maryland State Department of Health.

Discussion—Malcolm Pirnie, Consulting Engineer, New York City; H. L. Delsell of the Portland Cement Association, Chicago.

"Explosion and Health Hazards in Sewer Maintenance and Sewage Works Operation"—(A lecture and demonstration) G. W. Jones, Chemical Engineer, U. S. Bureau of Mines, Pittsburgh, Pa.

Discussion—Dr. R. R. Sayers, Chief Surgeon, Bureau of Mines and Surgeon U. S. Public Health Service, Washington, D. C.

"A New Process of Chemical Purification of Sewage"—(Illustrated) Major George H. Gleason, Chemical Engineer, Guggenheim Bros., New York City.

Discussion—Dr. W. Rudolfs, Chief, New Jersey Sewage Experimental Station, New Brunswick, N. J.

Following the presentation of the last paper an inspection trip will be made to the Guggenheim Laboratories where the experimental chemical sewage treatment plant is in operation. Major Gleason will explain the functions of each step constituting the process and answer questions.

The principal luncheon speaker will be George W. Fuller, Consulting Engineer, of New York City. Mr. Fuller will review the recent progress in sewerage and sewage treatment practice and discuss what appears to be the trends toward future developments.

The New York State Sewage Works Association holds three two-day meetings each year at selected points through the state. The annual meeting, however, is always held in New York City the day preceding the opening of the A. S. C. E. annual meeting.

DOUBLE PUMPING—TO AND FROM A STORAGE RESERVOIR

By W. COMPTON WILLS
Chief Engineer, Water Department, Wilmington, Delaware

THE water supply for Wilmington, Del., has been obtained from the Brandywine Creek ever since the abandonment of wells and springs utilized in the early days.

This creek, above the city intake, has a drainage area of 325 square miles, of which only 18.5 square miles or 5½ per cent lies within Delaware—the remainder lying within Pennsylvania.

Until recently, other than for occasional pollution problems, little fault has been found with this source of supply. However, the steady growth of Wilmington called for a study and eventually a development to insure an uninterrupted supply during periods of drought in the Brandywine. This, as is so common to other water works, resulted in the construction of a storage reservoir project of sufficient capacity to meet the expected deficiency.

Many sites for such a reservoir were considered. Those found along the Brandywine Creek and its tributaries were not favorable. The best of those at first considered, was one on a stream some five miles to the northwest of the city on Red Clay Creek. This site necessitated a dam for impounding the flows from some 45 square miles of watershed, with pumping facilities to the Brandywine Creek.

For many months efforts were made to start actual development of this so-called Red Clay Creek project. However, it became necessary, due to excessive costs of railroad relocation and uncertain problems of trade-waste disposal, to abandon it and look elsewhere—much as the search apparently would be in the dark to know where to look.

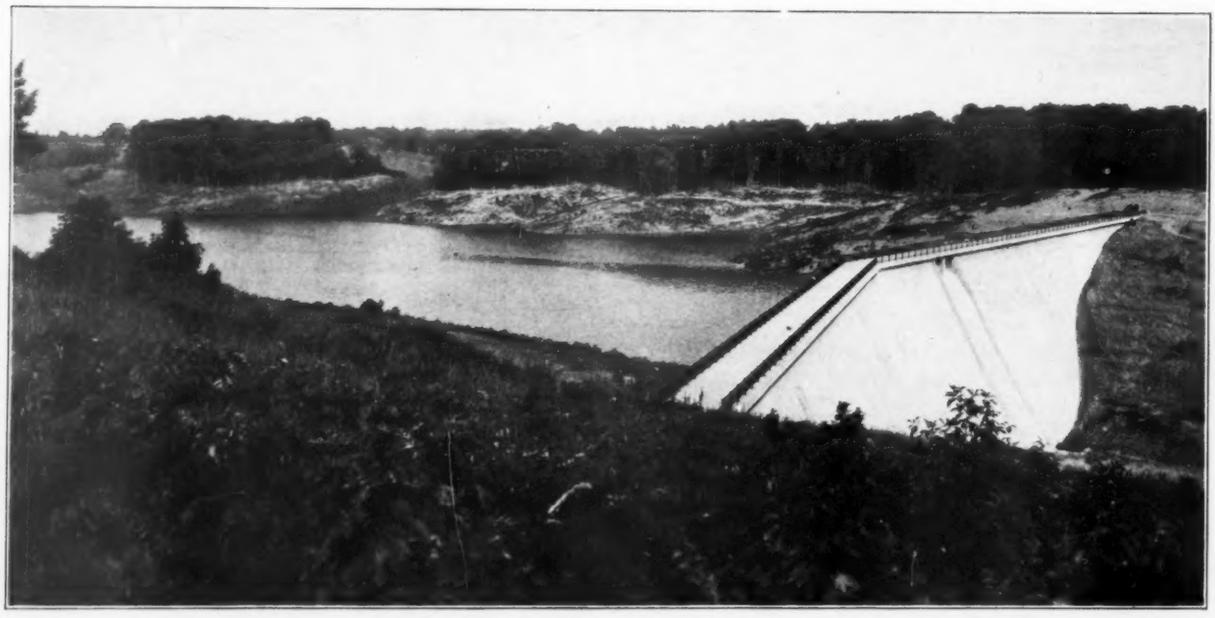
Not to be outdone in the solution of the city's problem, a sizable valley, with a very small stream trickling through it, was found just around the corner from the Red Clay Creek site. Study showed the feasibility of the development of this valley, and today it is in operation as the Edgar Hoopes Reservoir project.

A two-billion gallon reservoir with a length of 1¾ miles, and maximum depth of 100 ft., has been formed by the construction of a concrete masonry dam of gravity section, some 900 ft. long and 135 ft. high over all, at the maximum section. Some 480 acres of land were purchased. In addition roads were relocated, abandoned, and new ones constructed; also, some six miles of steel cylinder reinforced concrete pipe, 42-in. internal diameter were installed, the valley cleared, and a pumping station built below the dam.

As the small stream trickling through this valley was supplied by only 2 square miles of drainage area it became necessary to fill this huge pocket in the hillsides by pumping from the Brandywine Creek during times of plenty and repumping during times of drought—thus a double pumping proposition.

The construction costs of the Edgar Hoopes project were sufficiently less than those anticipated for the so-called Red Clay Creek project to justify double pumping.

The raw water stored is pumped from the Brandywine Creek during high flows by two 12 m.g.d. vertical triple expansion engines of the Holly Manufacturing Co. These pumps previously pumped to a slow sand filter plant through a 42-in. steel main. A connection was made between the old 42-in. steel main and the new 42-in. concrete main and the Holly pumps used simul-



The Edgar Hoopes Raw Water Storage Reservoir of the Water Supply of Wilmington, Del.

Interior of Old Mill Pumping Station, Wilmington, Del. Three American Centrifugal Pumps of 4 m.g.d. capacity each. Three Buffalo 6-Cylinder Gasoline Engines as Power Units

taneously to pump to the slow sand filter plant and to the new Edgar Hoopes Reservoir.

The pumping station located below the Hoopes Dam (see front cover) is equipped, for the present, with three 4 m.g.d. units, consisting of centrifugal pumps of the American Well Works, powered by gasoline engines of the Buffalo Gasoline Motor Co. Those pumps return the raw water to either the slow sand filter plant or to the Brandywine Creek, thence by raceway to a rapid sand filter plant.

Due to the intermittent operation of the station at the dam, gasoline engines were installed rather than electric motors which would carry a prohibitive standby charge.

Run-off from the small drainage area above the Hoopes Dam has not been counted on for storage, but allotted to seepage and evaporation.

Design was executed by Fuller & McClintock, New York City, with E. G. Manahan in charge.

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G. Gale Dixon Resumes Consulting Practice

G. Gale Dixon

G. Gale Dixon announces that he has resumed the consulting practice of civil engineering. For the past six years Mr. Dixon has been engaged, in the capacity of Deputy Chief Engineer, in the preliminary development, design, construction, and placing in operation of the complete new water-supply system of the Mahoning Valley Sanitary District, involving dam, bridges, pipe lines, water softening and filtration plant, pumping station, distributing reservoir, etc.

From 1922 to 1926, Mr. Dixon was associated with Frank A. Barbour, Consulting Engineer of Boston, Mass., in the practice of hydraulic and sanitary engineering under the firm name of Barbour & Dixon. Earlier associations were in the development of the water supply of the City of Akron, O., in the New York Board of Water Supply Organization on construction of the Catskill Aqueduct.

Mr. Dixon has for a long time been an active member of the American Water Works Association, and the American Society of Civil Engineers. In the former he serves as chairman of one of its most important committees — that on Transmission and Distribution of Water, which embraces twelve sub-committees.

The new offices of Mr. Dixon will be in the Home Savings and Loan Building, at 275 W. Federal St., Youngstown, O.

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Strengthening the Hand of State Health Authorities

The supreme court in the State of Ohio has recently rendered a decision that the State Department of Health has, without question, the legal right to order municipalities or private corporations to provide sewage treatment and likewise the power to enforce such orders.

Van Wert, Ohio voters had refused to approve a bond issue for the construction of a sewage treatment plant which the State Board of Health had ordered built. City authorities had refused to proceed with the project and as a result the matter was carried to the supreme court to serve as a test case.

Based on claims that funds were lacking and that the voters had refused to approve issuance of bonds for construction of sewage works ordered by the State the city officials refused to authorize expenditure of the $200,000 required for such works.

The decision of the Ohio court states that "Current expenses must be secondary to levies to meet mandatory requirements, such as discharge of bonded indebtedness or interest thereon, and also the compliance with orders of the State Department of Health issued under general state laws, which we hold to be mandatory."

There have been other instances of a similar nature recently—notably the case of Columbus, Ohio, whose citizens in November voted down a bond issue needed to construct sewerage treatment works ordered built by the state.

Considering the nation wide clamor for reduced taxation it is not unexpected that voters, lacking in regard for down stream neighbors, will fail to look with favor on expenditures for taking care of what leaves the "back door" of the community. That nothing was done by certain municipalities to improve unsatisfactory conditions already called to their attention in better times, is unfortunate. Now that in many instances nothing short of an official order to clean up will serve to insure something being done, it is fortunate for the good of sanitation that a supreme court has found compliance to be mandatory upon the municipality.

The decision in the Van Wert case will go far toward strengthening the hand of the health authorities in Ohio and in other states.

ACTIVATED SLUDGE BLANKET DEPTH DETECTOR

By S. VERMILYE

Superintendent,
Sewage Treatment Works and Sewers,
Tenafly, N. J.

IT has been found in the operation of the Tenafly N. J., activated sludge plant, that the home-made, inexpensive sludge blanket depth detector, illustrated herewith, proves very helpful as an aid to proper control. The rated capacity of the plant is 750,000 gals. per day. There are two "Dorrco" final settling tanks. Each tank is twenty feet square with a mean effective depth of ten feet six inches, and a gallonage of approximately 32,000. Aeration tank effluent enters the clarifiers or tanks through three six-inch pipes set along one wall, thirty inches below the water level. A vertical wooden baffle, eight feet deep, set two feet out from the wall, forces the incoming liquor to pass downward and thence flow upward to the effluent weir on the top of the opposite wall. This produces upward filtration through the sludge blanket and greatly increases clarification. By keeping the sludge blanket level above the bottom of the baffle it is possible to prevent a great deal of mechanical "wash" of the lighter sludge particles from the top of the blanket. Any sudden rise or fall of the blanket is detected, the reason ascertained, and proper corrective measures taken.

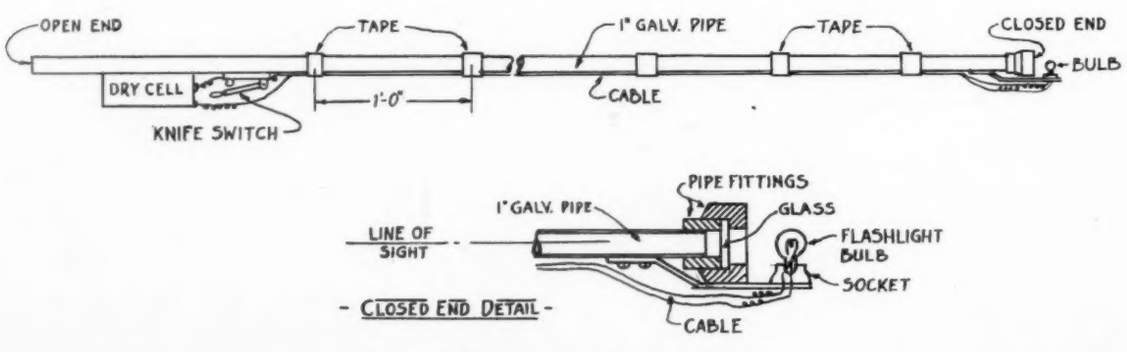
At night, during the period of minimum flow, there is a certain amount of increase in solids in the aeration tanks. As the flow picks up in the morning, there is an "unloading" of these solids to the clarifiers with a consequent rise of the sludge blanket. It is operating practice at Tenafly to start to draw excess sludge to the 600-gal. sludge conditioning tank coincident with the rise of the sludge blanket. (This point is indicated on the specimen chart showing one day's run.) Should a "bulky" sludge condition develop, the change in level of the sludge blanket in the clarifiers is noted in time to apply corrective measures. One of the most important advantages derived from the use of this detector is the fact that, by comparing the levels in the two clarifiers, it is possible to regulate the inlets so that each clarifier will take its share of the load and thus maintain a uniform density of the returned activated sludge from each.

From 6 a. m. to 6 p. m. the sludge level is read and recorded hourly, and from 6 p. m. to 6 a. m. every two hours. Sludge level is recorded on the chart shown herewith, in which the top line marked SURFACE indicates water level in each clarifier and each line below that, one foot in depth from the water level to the top of the blanket, which is indicated by the line connecting the hourly readings, recorded thereon.

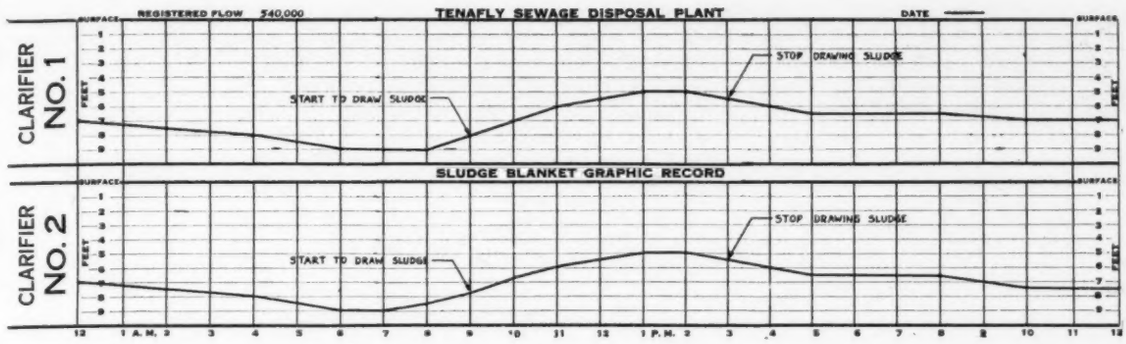
A few of the advantages of knowing sludge blanket depth and also current practice in the use of the detector, are covered by the foregoing paragraphs. Following is a description of the detector itself.

The detector is built upon a piece of one-inch galvanized pipe, eleven feet six inches long, with threads on one end only. At the threaded end, one-half of a pipe union is screwed on, a piece of window glass placed over the half union and the coupling nut of the union drawn down over that. It is best to put a rubber gasket on each side of the glass to make a watertight joint. A flashlight bulb in a suitable socket is then fastened so that the bulb is about one inch away from the glass end-piece and directly in line with the axis of the pipe. A piece of rubber cable is run from the connections in the socket along the outside of the pipe to a knife switch located near the upper end of the pipe. At intervals of exactly one foot, the cable is taped to the pipe. A dry cell connected through the knife switch furnishes the energy for lighting the bulb. All connections must be waterproofed, preferably with a plastic roofing cement. The accompanying sketch of the detector is self explanatory.

In use, the detector is lowered, bulb end down, into the clarifier, the bulb being lighted. The operator sights through the inside of the pipe, gradually



Sludge Blanket Depth Detector


REGISTERED FLOW 540,000
TENAFLY SEWAGE DISPOSAL PLANT
DATE
CLARIFIER NO. 1
START TO DRAW SLUDGE
STOP DRAWING SLUDGE
SLUDGE BLANKET GRAPHIC RECORD
CLARIFIER NO. 2
START TO DRAW SLUDGE
STOP DRAWING SLUDGE
SURFACE
FEET
12 1 A.M. 2 3 4 5 6 7 8 9 10 11 12 1 P.M. 2 3 4 5 6 7 8 9 10 11 12

Sludge Blanket Graphic Record

lowering it into the tank until he can see the sludge blanket around the bulb. (In cases where the blanket is dense, the light will practically go out when it reaches the sludge layer.) Holding the detector at the place where the "blanket" is seen, the operator then counts the number of tape markings submerged and reads directly the depth of the blanket for recording on the chart.

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Carrying Water Under Water

One of the largest diameter entirely arc welded water lines in existence has been installed in Hollywood, Calif.

Carrying water under water—that is the purpose of the steel pipe line, shown as it rests on a bench near the bottom of the Hollywood reservoir of the Los Angeles Water Supply System.

When the Los Angeles Department of Water and Power decided to build a second dam above the present Mulholland dam, it was necessary to lay a pipe line from the bottom of the new reservoir through the dam, along the bed of the first reservoir and down through the canyon where it would connect with the city mains. This shield-arc welded pipe line, 45 in. in diameter and 3460 ft. in length is to be submerged under 50 ft. of water when the project is completed.

We are indebted to the Lincoln Electric Company of Cleveland, Ohio, for the photograph used to illustrate this novel installation.

45 in. Diameter Steel Pipe Line Bringing Water through a Reservoir in Hollywood, Calif.

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Earle G. McConnell

Earle G. McConnell, who has for several years been Superintendent of Water and Sewage Treatment Works at Charlotte, N. C. died recently after a severe illness.

Mr. McConnell was one of the outstanding operators of water and sewage treatment works in America. He probably had the distinction of operating the Charlotte activated sludge sewage plants at as low cost as any in this country. He was a shining light to the younger operators in the South and had been invited to present operating papers before important associations all over the country. His valuable published articles have appeared in leading magazines and journals and for several years he has served as Editor of the Journal of the North Carolina Water and Sewage Works Association. In the latter association he had also held other important offices and had done much to make it outstanding and internationally known. In the American Water Works Association Mr. McConnell was active and had served on its Publication and Program Committee. On the Board of Control of the Federation of Sewage Works Association he represented North Carolina Association.

Charlotte has lost a highly efficient, faithful and capable municipal employee whom it will find it difficult to replace.

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The Depression Prolonged by Psychological Influences

In a New Year message to the employes of the Hackensack Water Co., which supplies 51 communities in Bergen and North Hudson Counties, New Jersey, President Nicholas S. Hill, Jr., urged that "all talk of depression be taboo." Mr. Hill suggested that the employes organize a committee to bring about the avoidance of pessimistic discussion. Were the workers of all public utility and industrial organizations to do this, he declared, public confidence—the virtue most needed now—would be restored, and recovery speeded.

EDITORIALS

WE FAVOR:

1. No diversion of water works revenues.
2. Laws permitting a city to issue "revenue bonds" for water works or sewerage improvements.
3. The passage of a "sewer rental law" in every State similar to that in Michigan.
4. Universal metering.
5. Universal treatment of water to secure not merely elimination of harmful bacteria, but freedom from hardness, odors and bad tastes.
6. Cessation of stream and lake pollution.
7. The pension system for municipal employees.
8. Licensing of consulting engineers and of operators of water and sewage treatment plants.
9. Periodic employment of consulting engineers to diagnose any economic troubles and prescribe the cures.
10. Elimination of "politics" from the construction and operation of water works and sewer systems.

Technocracy—Where Does It Get Us?

THE daily papers and the magazines are full of *Technocracy*—the new thought. The technocrats under the leadership of Howard Scott, a professor at Columbia University, present in a new book—*The A. B. C. of Technocracy*—the theories behind the new movement. They believe that the machine age has been responsible for the situation the world now faces which, they claim, an overproduction of goods is responsible for. The importance of man as a power unit in the United States, they say, is over with and that there is no possibility of returning to the time when the available man power will be needed during full time. As matters now stand, the technocrats say, this country has an installed capacity of one billion horse power to do work and, this being equivalent to ten times as much man power, there is required but two days of eight hours' work per week by each worker to run the machine of production. And there is no possibility of scrapping the machine.

Agriculture, basically the most important of all of our industries, utilizes but 7 per cent of the energy output of this country in the direct production of sustenance. The other 93 per cent, the technocrats report, goes to keep our social scheme going—make our clothes, warm our bodies, transport our goods and ourselves, and to bring us water. The technocrats tell us: "It must be remembered that the flow of energy can be exactly measured in units of heat—the calorie—or in units of work—the erg." Advocating that old standard of price and values be replaced by a standard of energy further explain that, "Such exact measure (of value) in dollars has never been possible nor can it be." A ton of coal, used as an illustration, brings varied prices in various seasons, yet it is always a ton of coal with its own very definite value in terms of energy, regardless of the dollar value.

As a result of research and analytical studies, the technocrats appear to feel that the present leaders of finance, industry and state should give over their places to scientists and engineers—technologists.

The technocrats would have us believe that overproduction is the cause of world economic troubles, but important economists hardly agree—saying that underconsumption is the real reason regardless of whatever measuring stick is applied to arrive at values. Water works men will probably agree with the economists as to the effect of lowered consumption.

The technocrats argue for the building of machines and automobiles which will last for a number of, rather than a few, years; of making shoes and clothing that will wear much longer than has been manufacturing practice in the past. They fail utterly, however, to meet the present day psychology face to face, regardless of what may be set up as ideal from a technocratic point of view. Leading industrialists have commented in reply, that they only wished that they had technocrats as competitors.

As to the matter of building machinery, equipment and automobiles to have much longer life than those manufactured in the past, it is hard to conceive of a man who would be satisfied to drive a 1920 model of a Ford automobile regardless of the "unused mileage" which it could still deliver.

In respect to productive machinery, boilers, pumps, motors and the like, many factories and municipalities would be money in pocket had such equipment been less long lived. Advances in the art of pump and motor design have resulted in putting equipment of materially improved efficiencies and reduced cost of operation on the market, but replacement of older equipment has not gone forward because of the existence of the *too serviceable*—one may say technocratic—type of equipment in use.

If the technocrat, using the erg or the calorie as the unit of value, now continued to rely on serviceable machinery which had been installed 15 years ago, he would still have something to worry about in the nature of the relative operating costs of the obsolete (not worn out) equipment which used more of his preferred units of value for producing steam or pumping water than would the newer equipment available.

There is ample evidence that continued operation of serviceable equipment is frequently uneconomic practice. Removal of such long lived equipment may go against the grain of one who has learned to depend on its performance and low up-keep cost, but it is of no interest to the progressive manager who has an eye open for increased efficiencies procurable from advanced practice and improved design of boilers, pumps, motors and turbines. It becomes only a matter of sharpening the pencil and calculating the losses which may be prevented by scrapping, or consigning to stand-by use, existing serviceable machinery and purchasing improved equipment for continuous use.

During this period of low cost of labor, materials and equipment, it behooves water works managers to look around for "technocratic equipment" which should be replaced for economy's sake.

L. H. Enslow

Water Works and Sewerage

Design-Construction-Collection-Treatment-Distribution-Disposal

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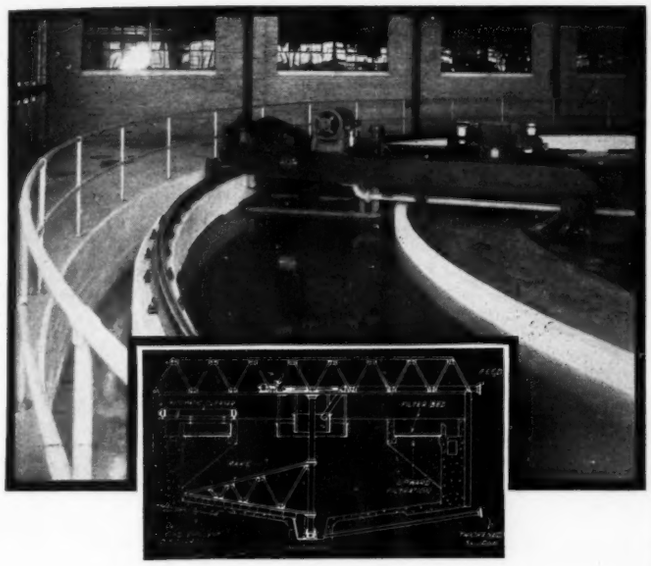

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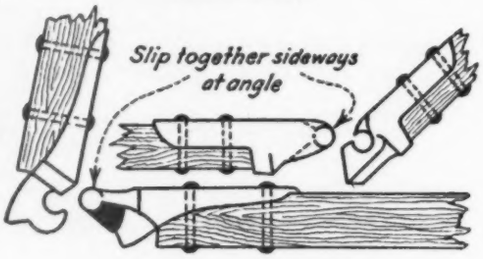

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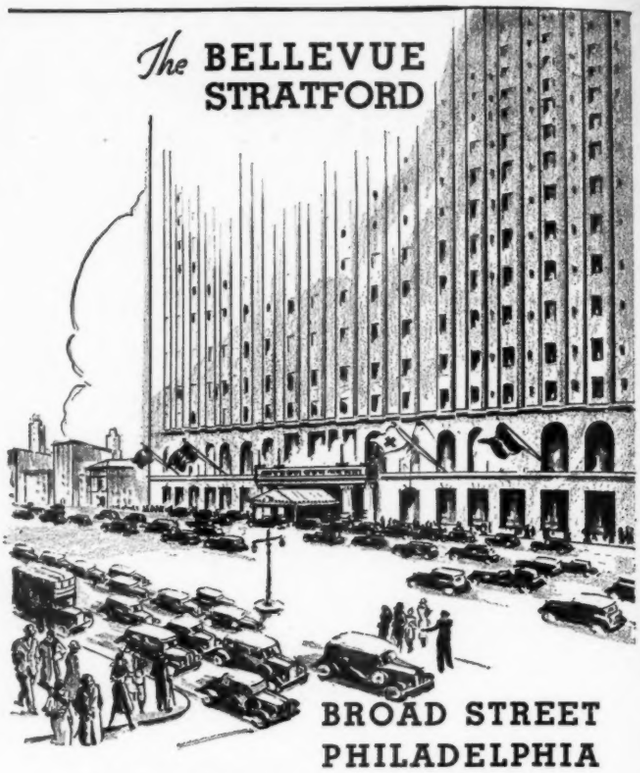

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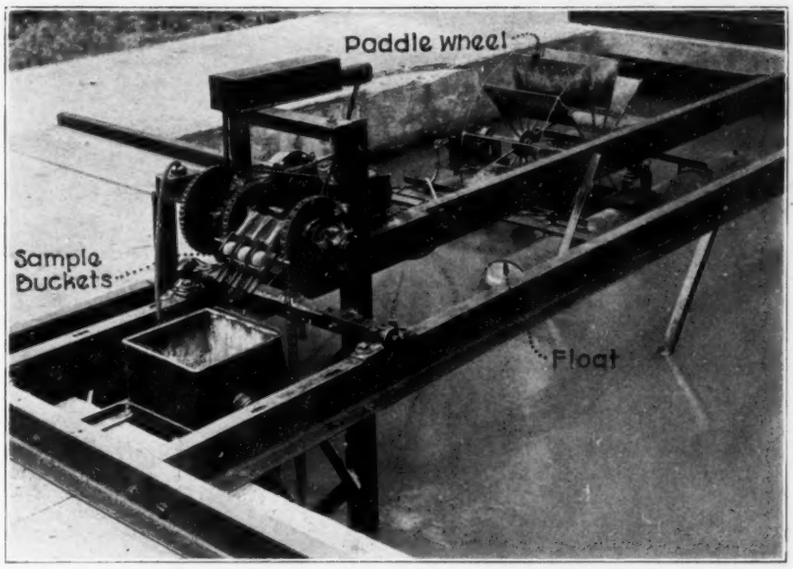

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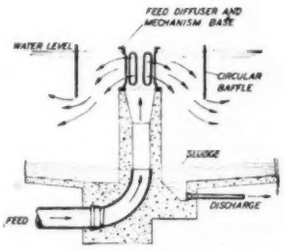

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